MAY-JUNE 1961

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In this issue: Mark S. Watson • Maj. Reginald Hargreaves • Dr. G. L. Haller • W. V. Kennedy
Col. R. G. Montgomery • A. G. Priest • Col. Virgil Ney • W. T. Adams • A. P. Levitt • T. L. Trexler

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ORDNANCE

LAND • SEA • AIR • SPACE

Forty-one Years of Leadership in American Armament Preparedness

VOL. XLV | MAY-JUNE 1961 | NO. 246

The Cover.—The Army's surface-to-surface solid-fueled Sergeant missile incorporates improvements in reliability, mobility, and simplicity over the Corporal missile which it will replace. It can fire a nuclear or conventional warhead.

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Managing Editor
Roger E. Lewis

Associate Editors
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Lorraine M. Van Horn

Contributing Editors
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ARMAMENT TECHNOLOGY

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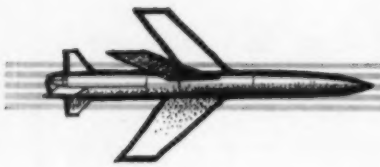

ON THE...

THE CONTENTS OF THIS ISSUE IN BRIEF

Underground Warfare (p. 770) . . . . Although guided missiles and nuclear bombs are much in the public eye today, much more emphasis should be given to our new land mines which are powerful and effective weapons to assure the swift passage of our combat troops or to harass those of an enemy and destroy even his heaviest tanks. Mines, mine laying, detection, and elimination are all discussed here with authority by Mark S. Watson, noted military correspondent.

Disarmament—and After (p. 775) . . . . While man still dreams of a peaceful world free from weapons, practical reality makes it clear that as long as the Communist objective is world domination disarmament must remain only a dream. "Armaments may constitute a mighty heavy burden," says Maj. Reginald Hargreaves, "but a rifle and pack are far more easily borne than the weight of a helot's chains."

Industry Studies Defense (p. 778) . . . . What weapons will future war demand? American companies have decided that they cannot wait for the Government to answer this vital question. According to Dr. George L. Haller they are initiating research programs today to determine how best to use their limited resources for possible national emergencies.

What of Manned Aircraft? (p. 782) . . . . Our doctrine of massive retaliation is gradually giving way to a more practical one of precision and selection, making the need for human observation and guidance imperative. "We can abandon the manned bomber, fighter, and fighter-bomber only if we are willing to abandon all objectives except simple survival and purposeless revenge," says Author William V. Kennedy, well-known military writer.

Weapons Readiness Now (p. 785) . . . . History shows how, time and again, the United States has suffered from a lack of preparedness. "The costs we have paid as a nation are reckoned in the hundreds of thousands of lives of our men, the waste of our material resources, and the squandering of our money." J. E. Trainer, president of the A.O.A., tells how the Association is trying to prevent such waste.

International Shooting (p. 787) . . . . Small-bore free-weapon competition is a type of marksmanship which United States shooters have been neglecting, says Col. Robin G. Montgomery, commanding the Army's Advanced Marksmanship Unit. However, we have the marksmen, and we can supply the accurate guns and ammunition required. So let's "get with it," the author says.

We Need Civil Defense (p. 791) . . . . Under the modern concept of "total war" the civilian population is in as much danger as the armed forces, and the lack of even elementary protection for U. S. citizens makes them an inviting target to enemy attack. Civil defense without shelters is like an air force without airplanes,

writes Anthony G. Priest, who also points out that fireproof buildings would save many lives even in peacetime.

Survival with Victory (p. 794) . . . . If the United States is to withstand a surprise nuclear attack and fight back successfully, our industry must plan now to wage "broken-backed warfare." Col. Virgil Ney recommends that this be done by dispersal of manufacturing complexes, protection of raw materials, the construction of underground plants, and the appointment of a Secretary of Emergency Industry.

The Ship-Shore Duel (p. 798) . . . . This sixth in the series of articles on Civil War ordnance tells how the Union Navy developed new tactics to combat the Confederate forts. They proved successful, says W. T. Adams, where the ships had room to maneuver, but the shore batteries had the upper hand where the channels were narrow and well fortified.

Shock-Wave Photography (p. 877) . . . . A continuing study of shock-wave phenomena is essential for the maximum effectiveness of explosive weapons, especially in such applications as missile warheads. A new technique, using reflectorized material, now makes it possible to photograph small-magnitude waves in daylight, according to David McLanahan.

Ceramics for New Weapons (p. 880) . . . . There is an increasing demand for the operation of weapon systems at ever-higher temperatures because of the significant improvements in thermal efficiency and effectiveness that can be obtained. Guided missiles, electronic components, nuclear devices, and even conventional weapons all are requiring more and more use of ceramics. Albert P. Levitt tells of the research being conducted in this field.

Supersonic Target Drones (p. 882) . . . . With offensive missiles now able to streak through the skies at several times the speed of sound it is imperative that we perfect our defenses against such weapons in enemy hands. According to T. L. Trexler the liquid-fueled ramjet-powered drone is well fitted to offer an elusive and relatively economical target to test our antimissile weapons systems.

New Alloy Aids Missiles (p. 886) . . . . The probe tube projecting from the nose of a guided missile is subject to extreme heating during flight, but A. I. Sprinz and R. L. Wachtell disclose how a newly developed coating of chromium and other metals can protect the parts from oxidation effects.

Bionics and Defense (p. 888) . . . . A new science unlocks the biological secrets of living cells and uses them for the advancement of military electronic systems, as outlined here by Walter A. Murphy.

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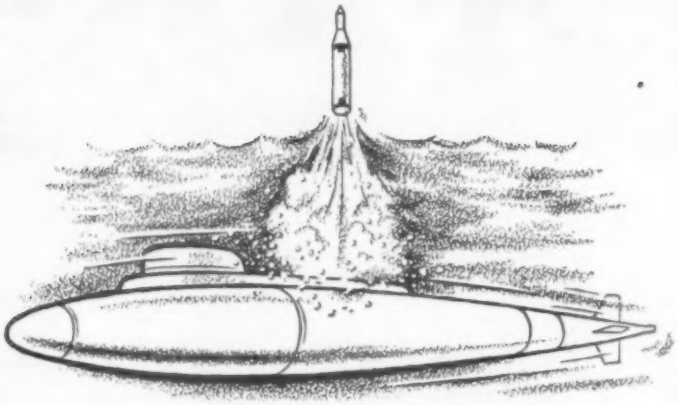

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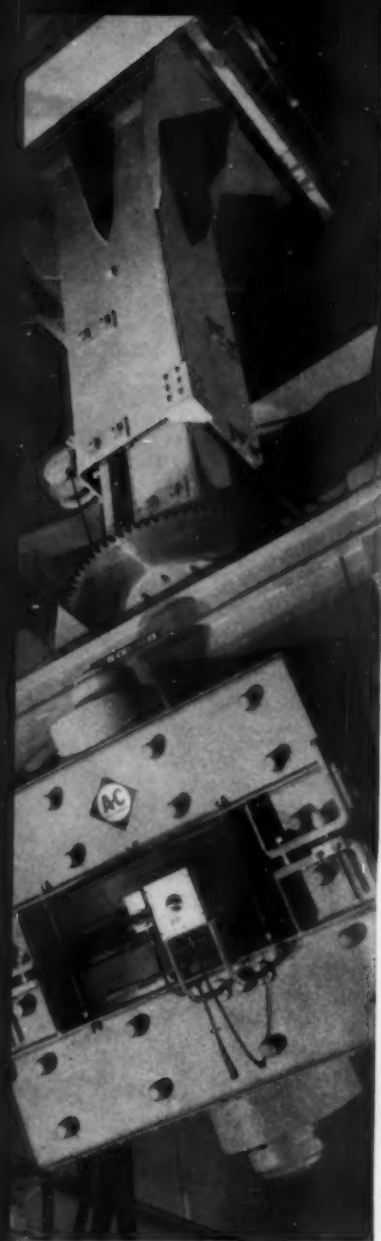

This giant eye is only one part of our complete nondestructive test installation at Bacchus. Through such steps, the life history of each individual unit becomes an open book—its reliability can be computed, its readiness known before the need arises. Such exacting tests pave the way to space.

Here twenty-five million electron volts probe the inmost secrets of a missile

Vastly more powerful than any known industrial X-ray apparatus, the Betatron yields a clear picture through the full girth of the third-stage Minuteman engine in an eight-minute exposure, contrasted with more than a nine-hour exposure required with 1,000 curies of cobalt 60. Resolution is such that irregularities down to 0.01 inch can be examined. Power of the instrument, and dimensioning of the building which houses it, are more than equal to the task of scrutinizing interior topography of the cast composite double-base solid-propellant motors made at Bacchus: the third-stage Minuteman, advanced second-stage Polaris, Altair, and the others.

XP61-1

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for ground support use...

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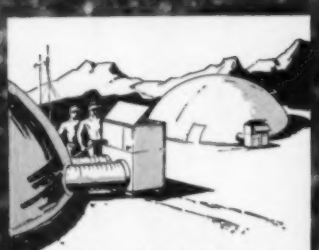

Inflatable shelter refrigeration unit, 7½ tons capacity (unit shown above)

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AIRESEARCH 400 cycle ac Freon ground air conditioners are the most reliable and compact systems produced for ground cooling applications. They are easily transportable by helicopter or ground vehicle to any field location.

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Base and shaft of pintle bearing assembly for giant telescope.

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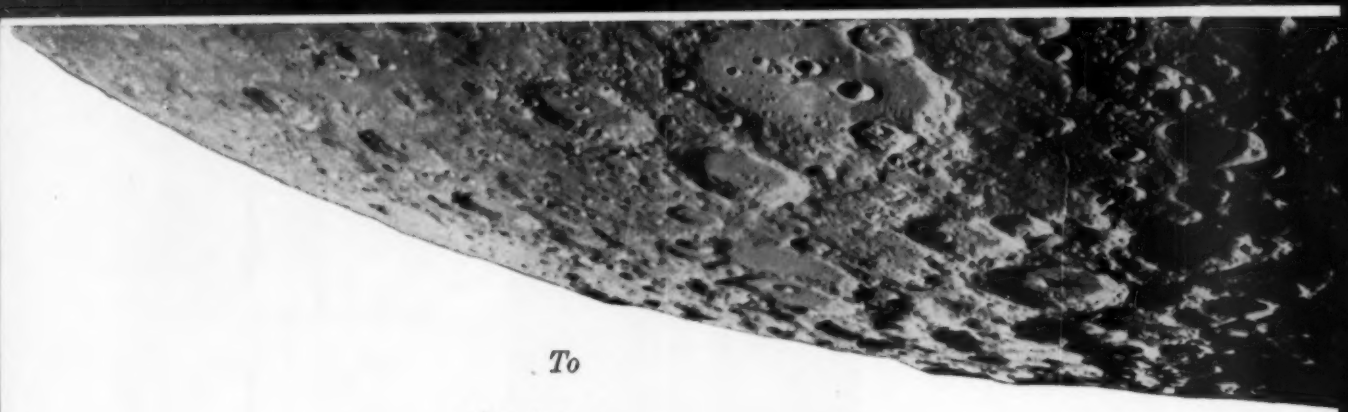

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CALTECH'S JPL RANGER, to carry research instrument packages to the moon, will rely upon precision design, construction, testing and performance of Motorola electronic equipment. Comprehensive measurements of operational and navigational data aboard will be assembled for transmission by its Flight Data Encoder. An all solid state Transponder generates the telemetry carrier, receives ground commands, and translates carrier frequencies for two-way Doppler velocity measurements. ☆ In laboratories and at launch site, Payload Test Sets will check out the spacecraft RF communications system. At NASA's transmitter and receiver sites, Calibration Beacons will check command transmitter performance and radiate precise signals to test telemetry receivers. ☆ Motorola's participation in Ranger lunar probes demonstrates its space communications capabilities for frontier programs.

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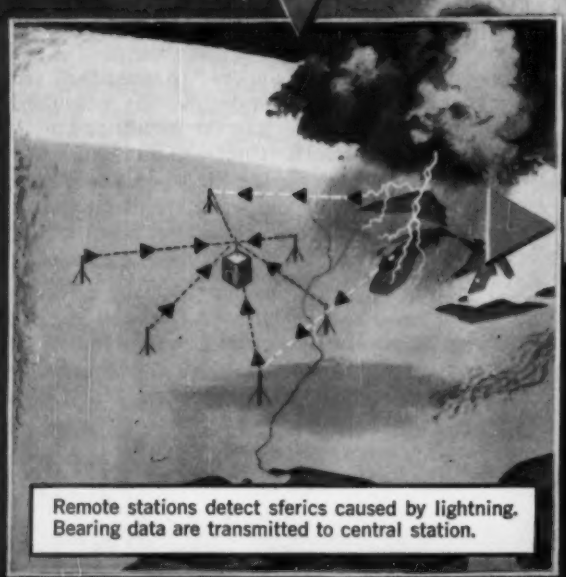

Remote stations detect sferics caused by lightning. Bearing data are transmitted to central station.

At central station data from remote sites are triangulated and displayed.

Flashes of light on kinescope indicate lightning's location.

Now... Forecasting by Lightning

New Lockheed Electronics weather system spots storms up to 2,000 miles away

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Now, Lockheed Electronics has produced, in conjunction with the Army Signal Corps and Air Force, a unique system that pinpoints all lightning flashes within a 4,000-mile area.

Remote antennas pick up radio signals generated by sferics. Processing equipment converts the signals into directional data and transmits the information to the Air Force's Severe Weather Warning Center in Kansas City, Missouri. There, after triangulation, the signals are traced on a display which gives the storm's location and path.

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LEC is contributing importantly in a variety of ways to development of equipment to advance meteorological knowledge. Among current projects are high performance radiosondes and wind data conversion systems.

MINDING THE FUTURE

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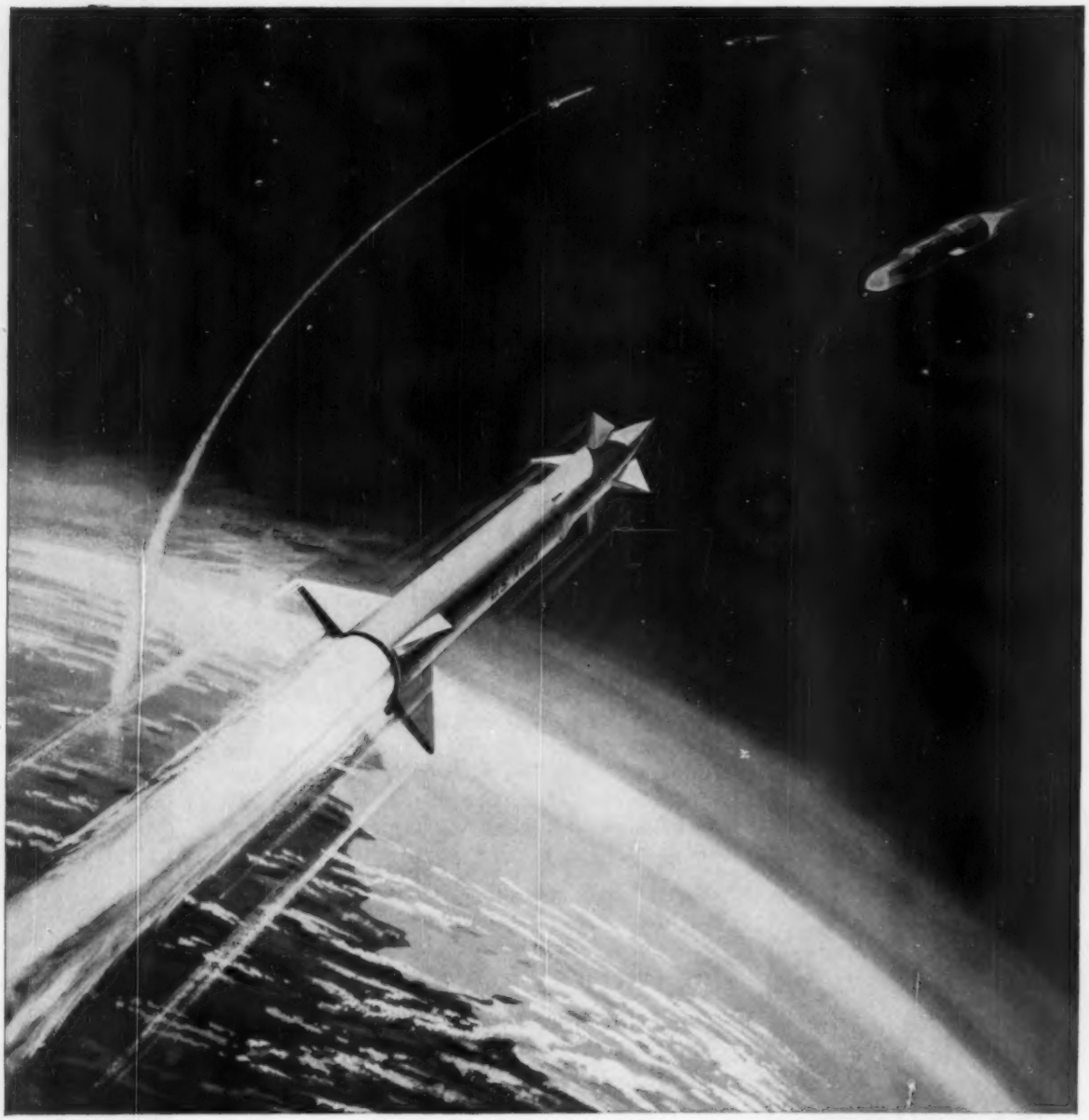

With its tremendous thrust, *Zeus* can intercept attacking missiles far from the area it defends

Army's Zeus is designed for a hit every time on supersonic bull's-eyes!

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DOUGLAS

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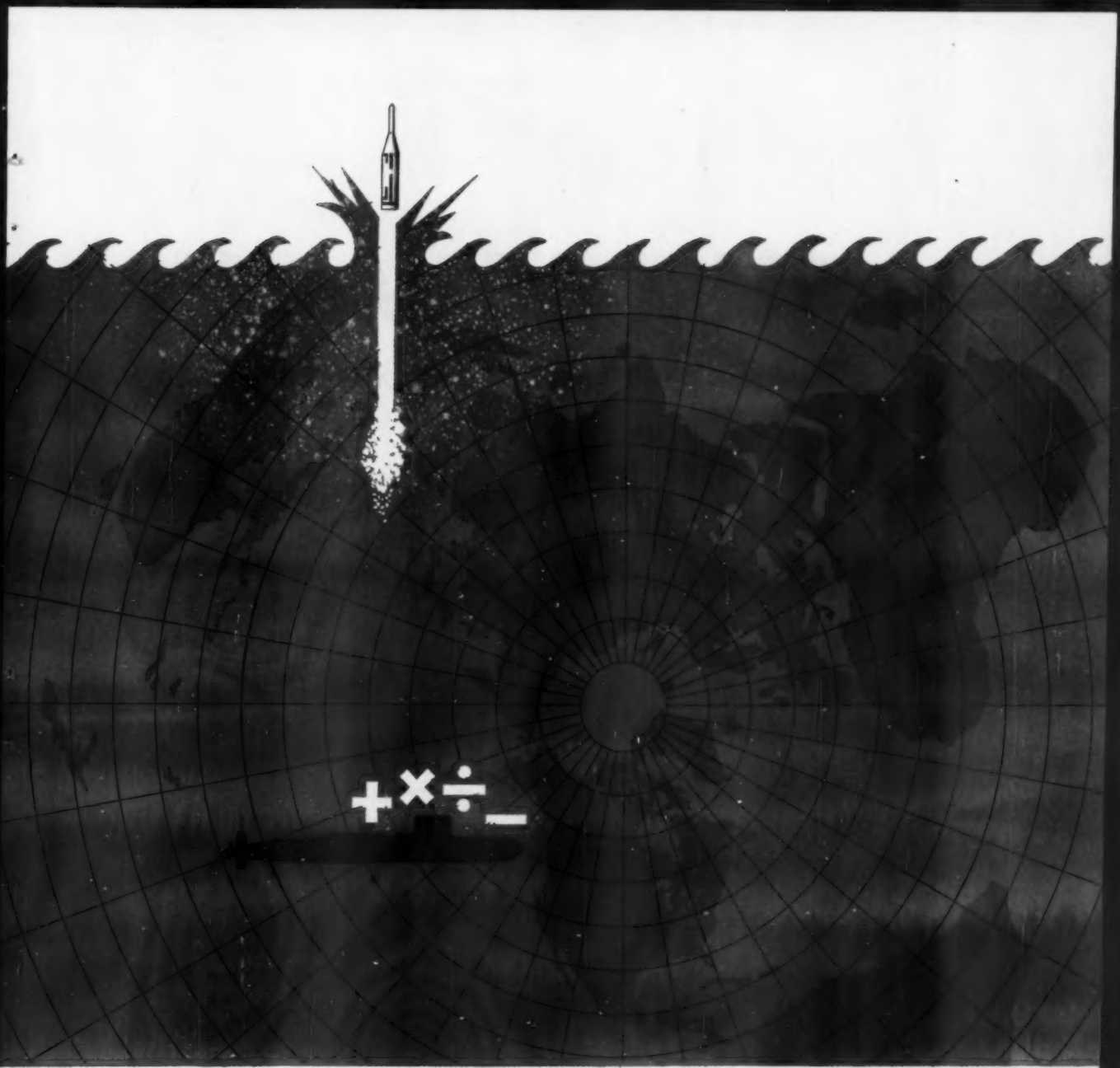

*COMP'UTENCE

at work in Polaris program

The mission: to develop and manufacture the electronic digital computer that provides stabilization for the submarine periscope or radio-metric sextant; resolves celestial information in bearing and elevation order signals; provides data for the correction of the inertial navigator; and compensates for the effects of roll, pitch, heading, and mast flexure. **The means:** Burroughs Compútence. **The results:** precise launchings for Polaris. **Other USN missions-accomplished:** Polaris Fire Control Switchboards, aircraft carrier landing systems (through Burroughs Control Instrument Co.), and advanced digital airborne computers. **The message:** Be it by land, sea, air or space, Burroughs Compútence—ranging from basic research through production to field service—takes its bearings, goes straight for the goal. Burroughs–TM

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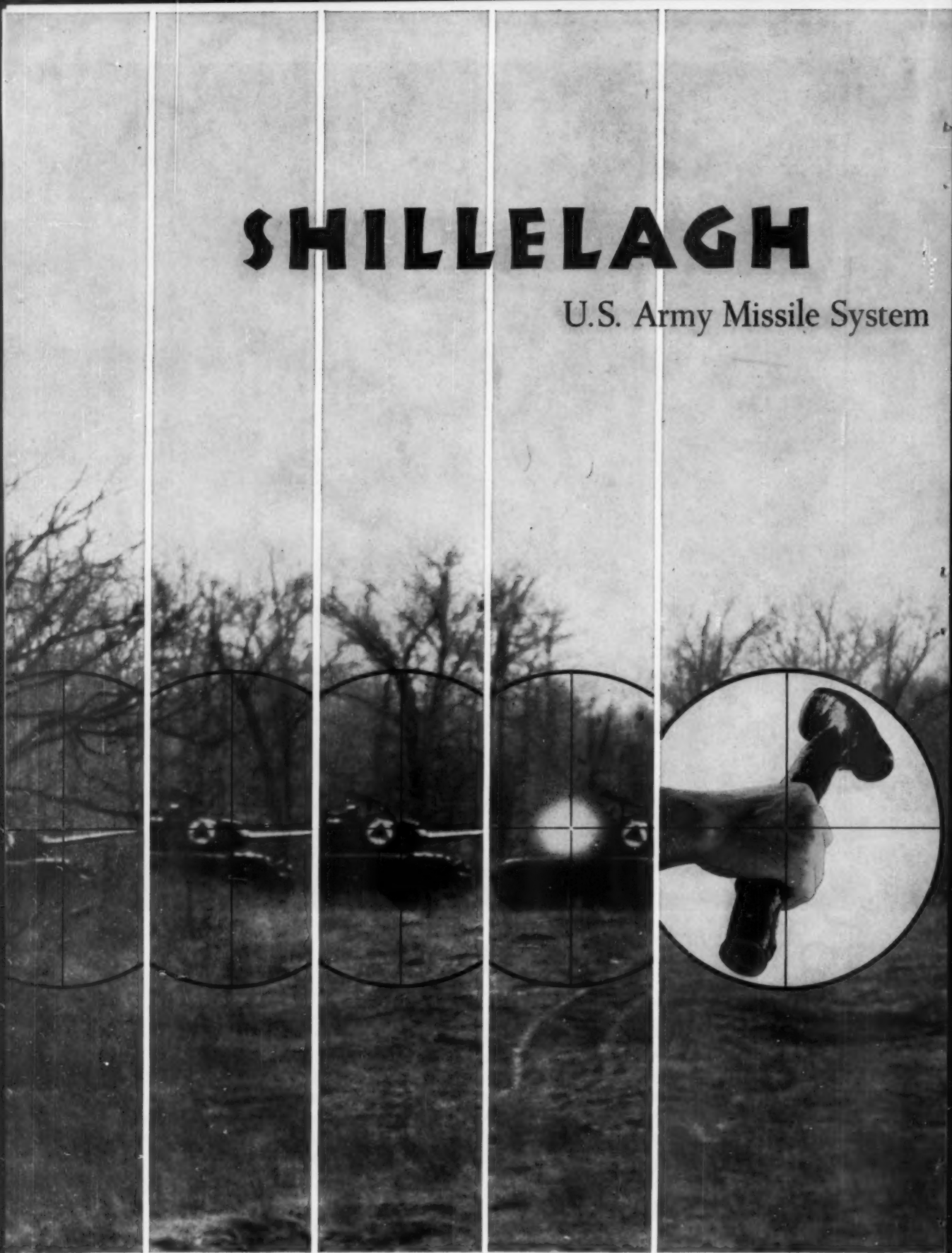
SHILLELAGH

U.S. Army Missile System



The **SHILLELAGH** is being developed for the U.S. Army under the over-all direction of the U.S. Army Ordnance Corps.

The United States Army SHILLELAGH surface-to-surface guided missile–like its Irish namesake–will be simple, reliable... lethal. Against enemy targets–moving or stationary–**SHILLELAGH**'s accuracy and firepower will provide the U.S. Army a devastating new weapon that kills with a first-round probability approaching unity ...and at ranges never achieved in antitank warfare. **SHILLELAGH** is now under development at Aeronutronic, prime contractor on this advanced weapon system.

AERONUTRONIC DIVISION *Ford Motor Company*, DEFENSE PRODUCTS GROUP
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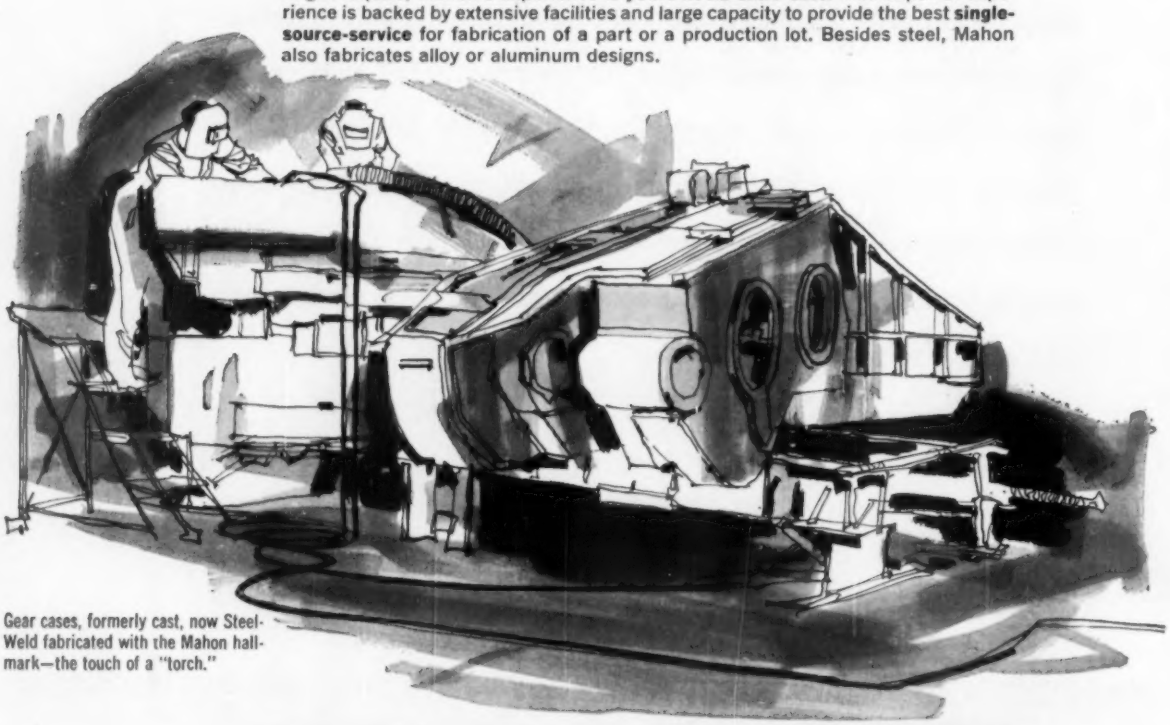

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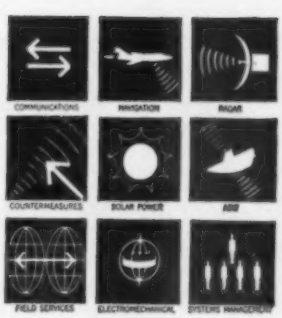

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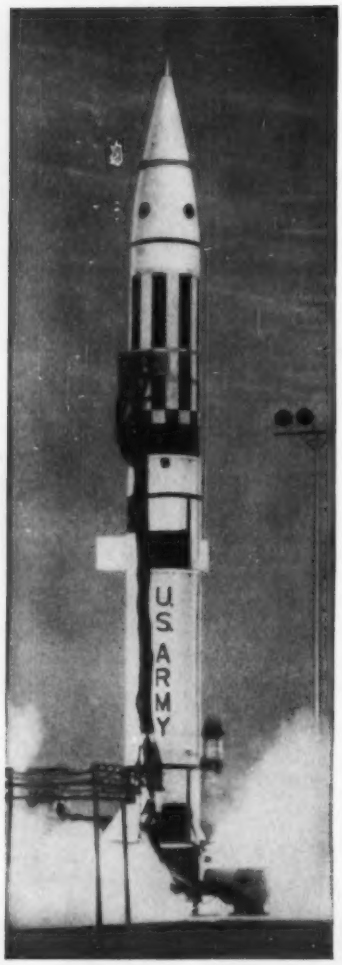
SIGNIFICANT DEVELOPMENTS AT HOFFMAN HAVE CREATED POSITIONS FOR SCIENTISTS AND ENGINEERS OF HIGH CALIBER, PLEASE ADDRESS INQUIRIES TO VICE PRESIDENT, INDUSTRIAL RELATIONS



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for the Pershing missile.

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Aerojet's achievements in the structural materials field are based on extensive investigations of metals, plastics, and ceramics and on new approaches to filament winding, plastic lamination, and other composite fabrication processes.

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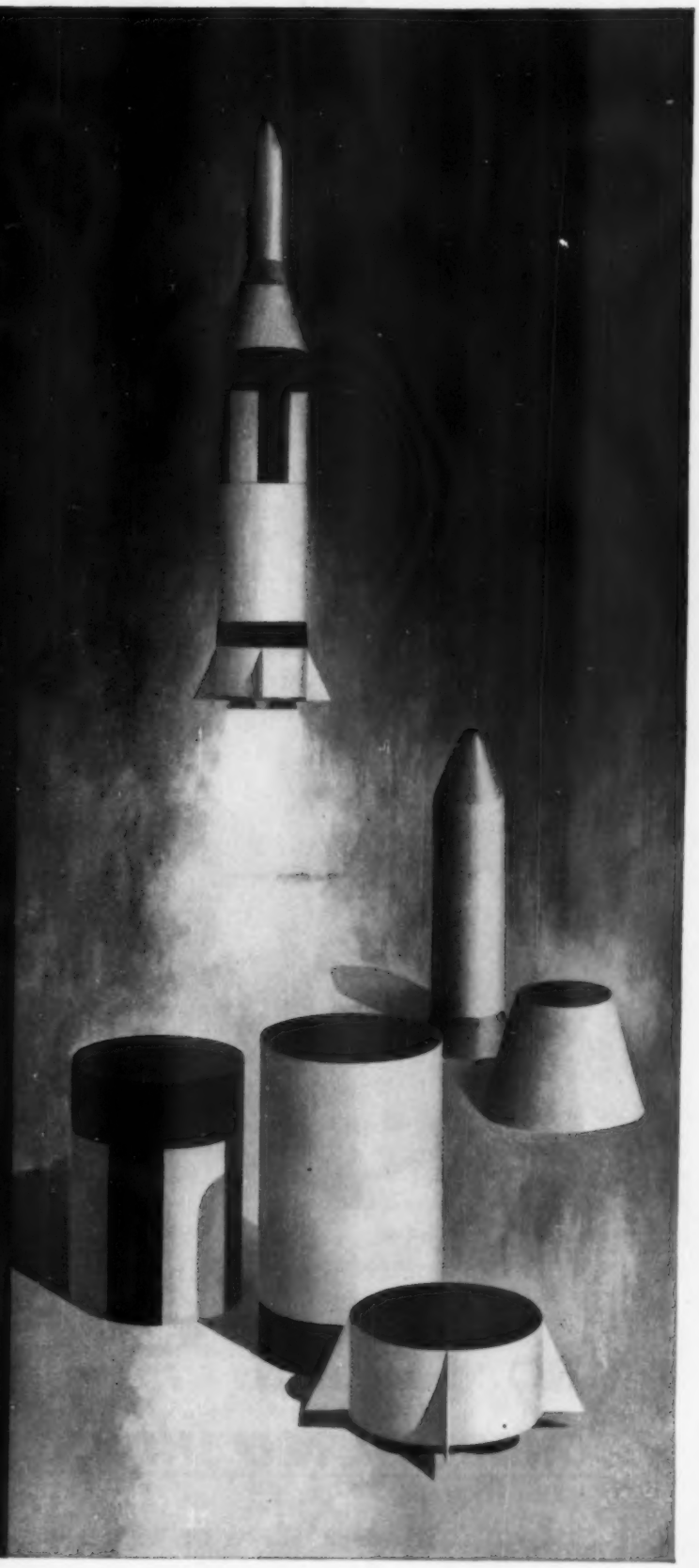
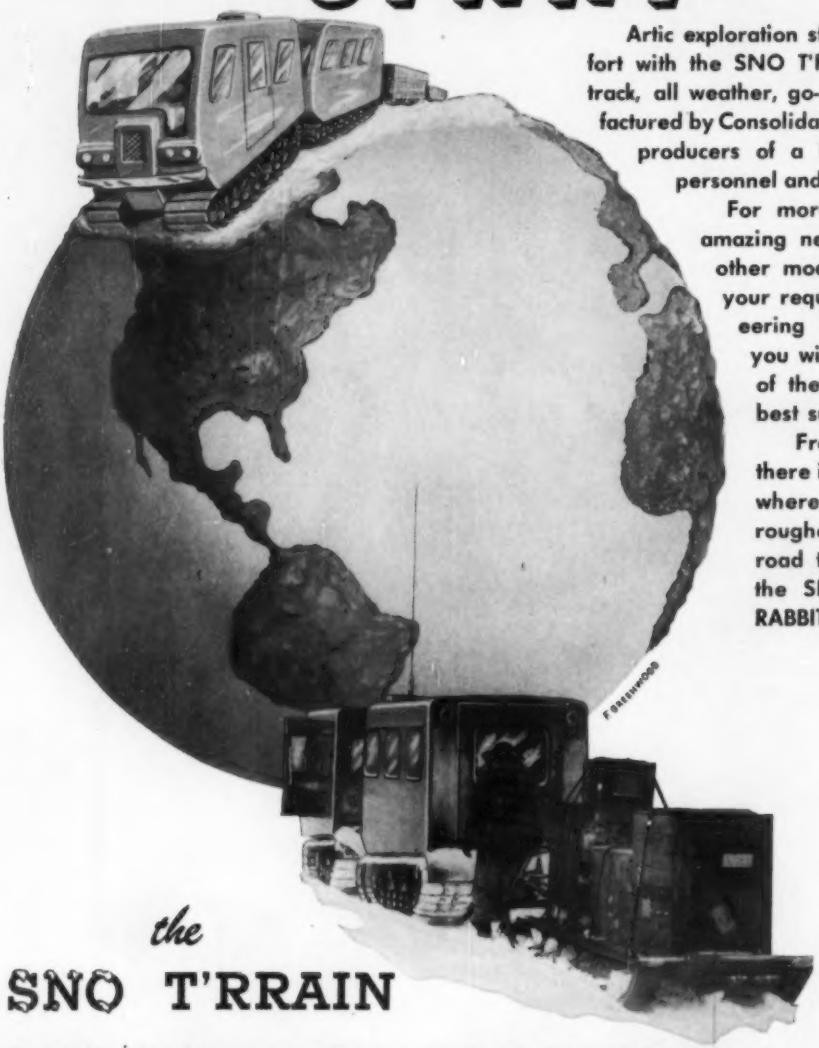


TAKE A GIANT STEP



Artic exploration steps out in style and comfort with the SNO T'RRAIN — the unique four-track, all weather, go-anywhere vehicle. Manufactured by Consolidated Industries, Dover, Del., producers of a full line of go-anywhere personnel and equipment carriers.

For more information about this amazing new four-track vehicle and other models, send us a listing of your requirements and our engineering department will provide you with a complete prospectus of the vehicle and components best suited for your conditions.

From the equator to the pole there is a Consolidated Go-Anywhere vehicle to solve your roughest and toughest off-the-road transportation problem — the SNO T'RRAIN - the SNO RABBIT - the SWAMP FOX.

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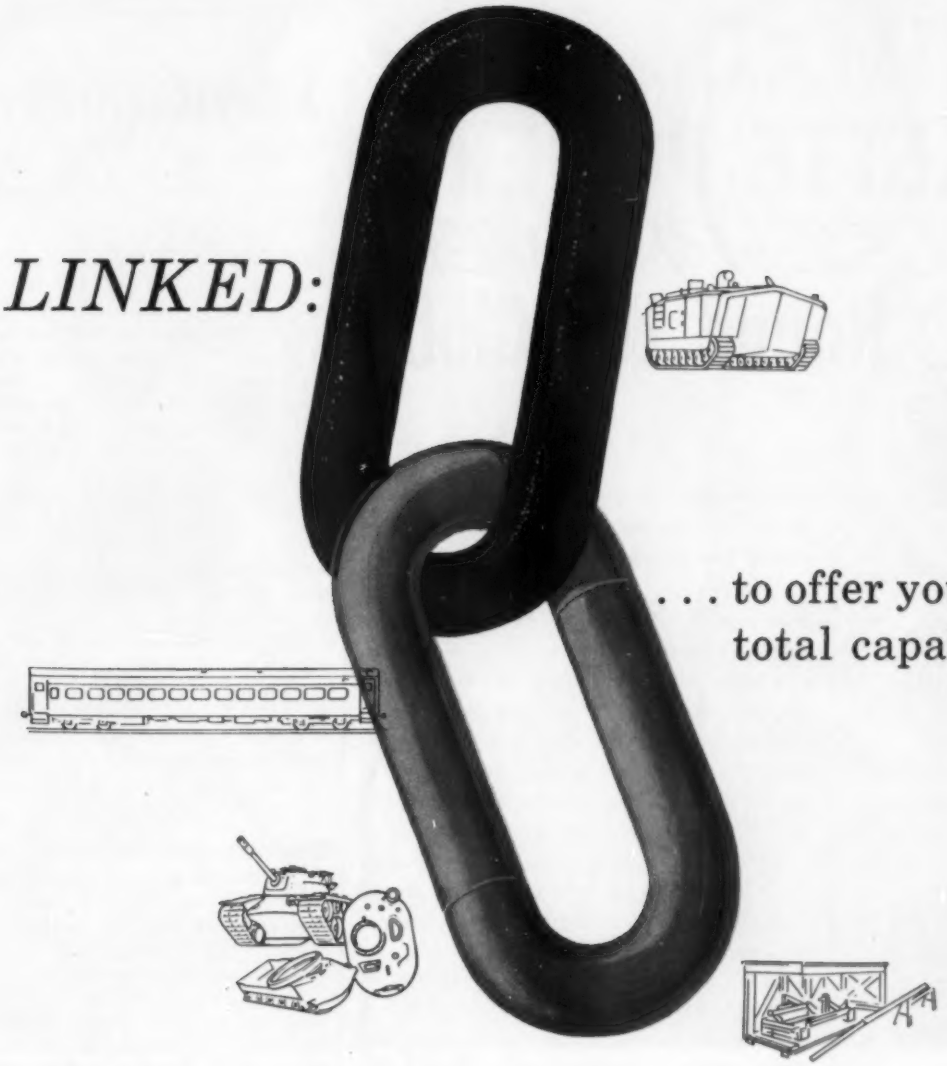

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Rely on St. Louis Car, a foremost metal fabricator for more than 70 years . . . dependable builder of transportation, ground support and defense equipment ranging from major assemblies to special fabrications.

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Turn to General Steel, a reliable source of steel castings for nearly 60 years . . . specialists in complete design and production . . . long an armed forces supplier of such components as cast armor tank hulls and turrets.

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Since the acquisition of St. Louis Car by General Steel, the considerable experience of two capable organizations works to the benefit of the military in developing and producing equipment of conventional or entirely new design.

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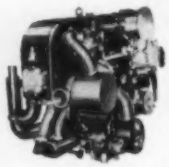
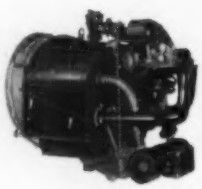
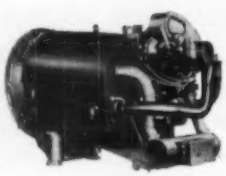


PC-30
2-cyl. 34 hp.

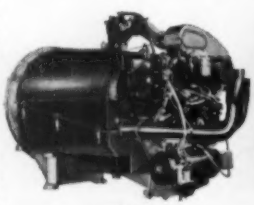
PC-60
4-cyl. 70 h.p.



PE-90
4-cyl. 110 hp.



PE-150
6-cyl. 175 hp.



PE-200
8-cyl. 250 hp.

Ground support equipment built around Packette power is proving itself today on defense installations all over the free world.

Developed by Continental Motors, with the famous Continental air-cooled aircraft engines as their basis, these five Military Standard models [Mil. E-26248 (USAF)] range from 30 to 250 hp, combine compactness and light weight with ease of servicing and upkeep, and operate at any temperature from equatorial heat to polar cold. Of special interest and importance, as simplifying maintenance in the field, is the wide interchangeability of parts among the several Packettes, and between them and the models in the Continental aircraft engine line.

They're use-proved NOW in air conditioners, compressors, crash trucks, generators, test stands, refuelers, heaters, blowers, Rollagons, multi-purpose tugs and other applications. Experience is proving: IF THE APPLICATION FALLS WITHIN THEIR POWER RANGE, NO OTHER ENGINE WILL DO THE JOB SO WELL.

WRITE FOR COMPLETE INFORMATION

Continental Motors Corporation
AIRCRAFT ENGINE DIVISION
MUSKEGON, MICHIGAN

ATOMIC ENERGY

New Atomic Clock

An atomic clock, so accurate that its maximum error would not exceed one second in 1,271 years, has been developed for the Air Force. The airborne device which uses atomic energy as a power source is technically referred to as an airborne atomic frequency standard. It should become operational for use in Air Force missiles and aircraft next year.

The 62½-pound device will replace the numerous crystal oscillators, used as frequency or time standards, now required to calibrate airborne communications, navigation, guidance, fire-control, computing, and timing devices.

First of its kind to be developed, the unit has been simplified to the extent that only a simple on-off switch is required to operate it. The small clock not only will be airborne but can also replace the present-day atomic laboratory units weighing over 600 pounds. No radiation hazard is involved in its operation.

Oceanographic Research

The Atomic Energy Commission awarded two contracts for oceanographic research which would be important in making predictions about ocean current distribution of radioactive isotopes.

One of the contracts was awarded to Columbia University's Lamont Geological Observatory, Palisades, N. Y., for a study of the mixing, diffusion, and circulation rates in the oceans. The other was awarded to the Systems Engineering Division of Pneumo Dynamics Corporation, Washington, D. C., for development, fabrication, testing, and delivery of equipment to be used in the ocean-current study.

The study will involve placing a commercially available, nontoxic, nonradioactive, fluorescent dye (Rhodamine B, a common red pigment used in lipsticks) in selected areas of the ocean. It is expected that the dye will remain detectable for a period of approximately one week. Water will be sampled by a ship-towed detecting device containing a flucrometer, which is sensitive enough to record as little as 2 parts of dye per 100 billion parts of water.

The device, which has a diameter of one foot and is six feet in length, will also contain other instruments to measure the temperature and depth of the ocean water being sampled. Initial measurements will be made at high ship speed (11 knots) to depths of 655 feet; later work will be conducted at greater depths—down to 18,000

(*Continued on p. 761*)

PROJECT HEAT

FOR MILITARY APPLICATIONS

In cooperation with research and engineering commands of the U.S. Armed Forces, Hunter Manufacturing Co. for more than twenty years has specialized in the design, development and manufacture of multi-fuel-burning heating systems.

Hunter heating systems with *sealed-in-steel* combustion are employed for a wide variety of military uses—for space and personnel heating in mobile shelters, in portable or fixed structures of many different types, in self-propelled vehicles, in ground support systems for missiles, in radar and microwave systems, etc.

Other types of Hunter systems are widely used in winterization operations, for engine pre-heating, for emergency heating requirements and for many other using arm operations. Hunter heating systems are designed for cold starts down to 65° below zero and are air-circulating in type with thermostatic controls. Uncontaminated heat capacities range from 15,000 to 300,000 BTU/hour.

If you have a problem involving the application of heat, Hunter can help you solve it.

Complete research and development facilities available. Contact:

SPECIALISTS IN HEAT FOR MILITARY APPLICATIONS

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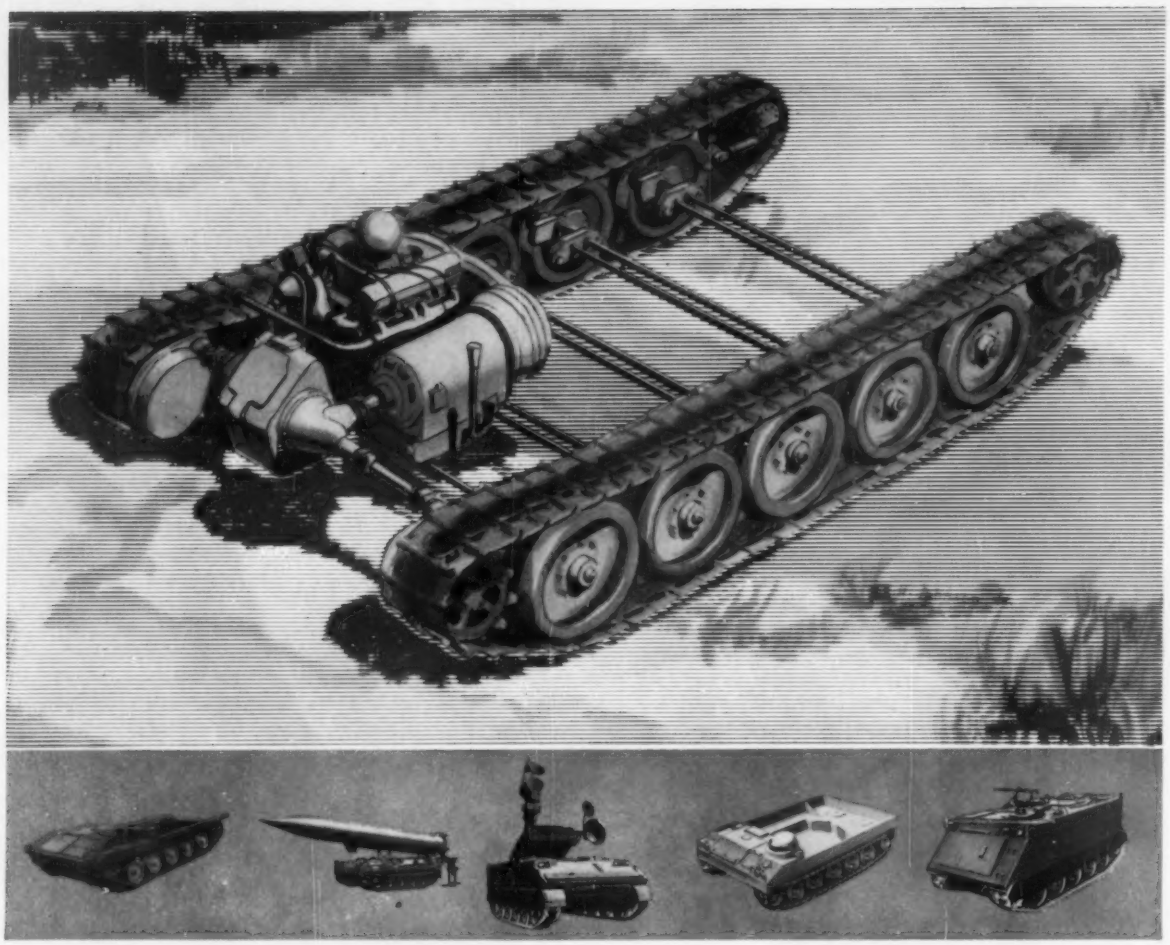


STANDARDIZATION CUTS R & D COSTS AND REDUCES MILITARY LOGISTIC BURDEN

Food Machinery and Chemical Corporation, working closely with the Ordnance Tank Automotive Command and the using forces, has put the standardization idea to work.

A prime example is the modern Army's multipurpose vehicle family. Based on the M113, an entire family of vehicles ranging from armored personnel carriers to unarmored missile carriers has been developed that uses the same engine, power train and suspension as interchangeable components. This standardization saves research and development dollars, adds production economy, and eases logistic problems in field operation.

Take advantage of these cost saving factors in planning your mobile GSE equipment. Call in FMC engineers at the concept stage of your project.

For further information, write on company letterhead to Preliminary Design Engineering Dept., FMC Ordnance Division, P.O. Box 367, San Jose, Calif. Phone CYpress 4-8124.

Putting Ideas to Work

fmc

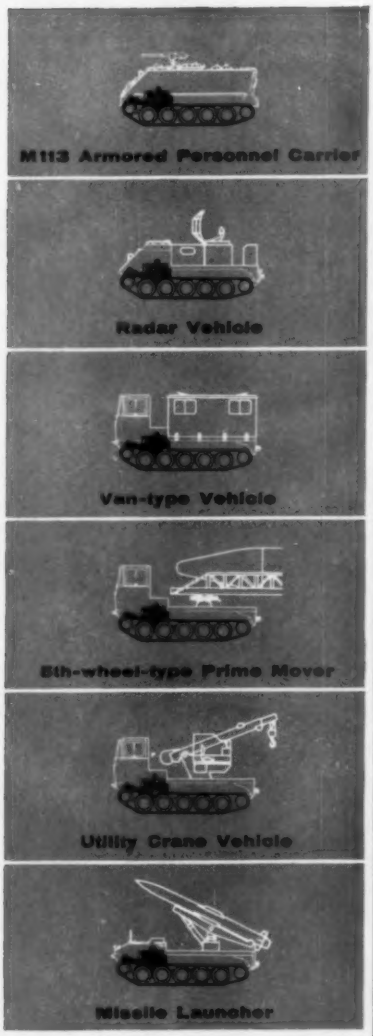
FOOD MACHINERY AND CHEMICAL CORPORATION

Ordnance Division

1105 COLEMAN AVENUE, SAN JOSE, CALIF.

fmc

Illustrated below are just six of the operational or proposed adaptations of the standard multi-purpose vehicle family. All feature full track suspension to insure full off-road mobility on any terrain. Vehicles can be amphibious, air transported and parachute dropped.



Atomic Energy (Contd.)

feet—at reduced rates of speed (2 knots).

The project represents the first application of a dye concentration measurement system for tracer studies of circulation in the deep ocean beyond the continental shelf.

Actual or potential sources of ocean-borne radioactivity are: fallout from past nuclear detonations, atomic plants located near the seacoasts, low-level wastes disposed of at sea, and the operation of nuclear surface ships and submarines. Loss or disposal of nuclear-powered aircraft or unmanned space vehicles may be an additional source of ocean radioactivity in the future.

Mobile Reactor

The Mobile Low Power Reactor No. 1 (ML-1) achieved criticality (sustained chain reaction) recently at the Atomic Energy Commission's National Reactor Testing Station in Idaho.

The start-up was another step in the joint development by the Commission and the U. S. Army Corps of Engineers of a small mobile nuclear power plant and power-conversion system to meet an Army requirement.

The ML-1, which has been under development for about five years, is the world's first direct- and closed-cycle gas-cooled nuclear power system. In this system, the gas, heated in the reactor core, is used to drive the turbine and then is returned to the core.

The entire plant is skid-mounted in six packages totaling less than thirty-eight tons and can be transported by standard Air Force cargo aircraft, standard Army low-bed truck-trailer, train, or barge.

The reactor, which is water-moderated, nitrogen-cooled, and capable of generating approximately 3,400 thermal kilowatts, can be placed in full-power operation 12 hours after arrival and readied for movement to a new location 24 hours after shutdown. Other characteristics are reliability for continuous operation in extreme climatic condition and ruggedness.

New Reactor Insurance

The Atomic Energy Commission has approved an amendment to its regulations, 10 CFR, Part 140, which will require a moderate increase in public liability insurance or other financial protection on some nuclear reactors licensed by the Commission and located in more highly populated areas.

Financial protection is required of the reactor licensees by the Commission in order to qualify for Federal Government indemnity of up to $500 million per nuclear incident. The indemnity provides for payment of claims growing out of a nuclear accident which exceed the amount of insurance coverage or other financial protection held by the reactor licensee.

The Commission's present regulations establish minimum amounts of financial protection, commencing at $1 million, for the smaller reactors and prescribe a formula for determining the amounts to be required for the larger reactors not covered by a statutory requirement. The Atomic Energy Act of 1954 requires that reactors having a power level of 100,000 electrical kilowatts or more must be covered by the maximum amount of insurance available from private sources. This now is $60 million.

Under the amendment to AEC regulations approved by the Commission, the formula to be used for reactors above the minimum amounts and below the statutory requirements now will require somewhat higher financial protection for reactors located in more highly populated areas. The basic elements of the formula, *viz.*, power level and location, are continued. The Commission feels, however, that the range of values previously assigned in the formula to location factors did not adequately reflect relative differences in location.

The new formula for computing financial protection requirements is: Base amount of insurance ($150,000 times the megawatt rating of the reactor) multiplied by the location factor (1 to 2). The location factor formerly used was 1 to 1.5. In arriving at a location factor within the prescribed range, the Commission takes into account the total population of the area surrounding the reactor and the proximity of that population to the reactor site.

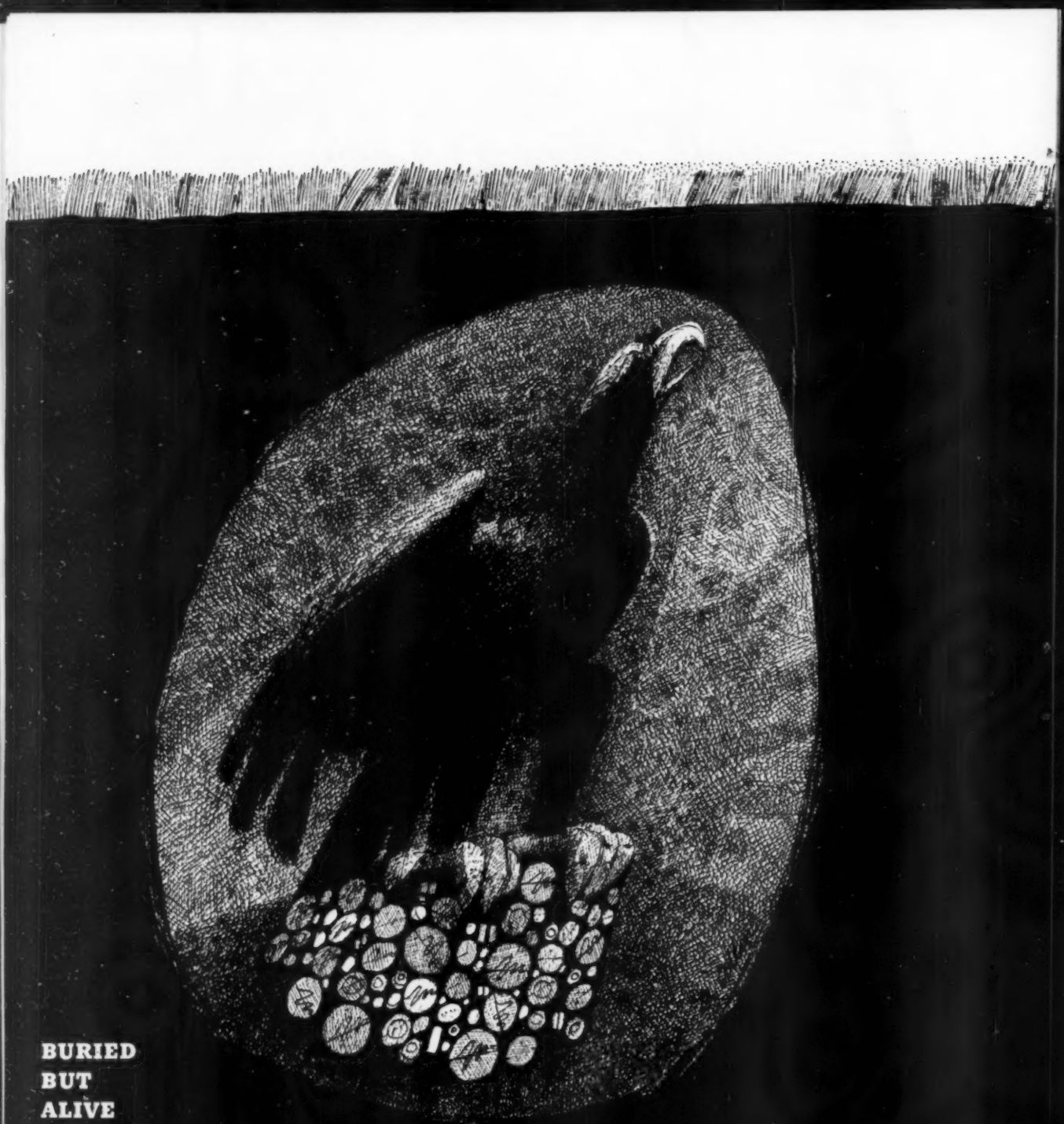
A-Power for Space

A tiny prototype lightweight reactor to generate heat for the production of auxiliary power for space vehicles achieved criticality (sustained chain reaction) on April 4, 1961. The reactor weighs 200 pounds without shielding and is fueled with a uranium-zirconium hydride alloy. The reactor core is thirteen inches high and nine inches in diameter.

Designated the SNAP 2 Development System (S2DS) Reactor, it is the second to be designed, constructed, and operated for the AEC by Atomics International, a division of North American Aviation, Inc., Canoga Park, Calif., as part of the development of a SNAP 2 reactor-electric power system for space vehicles.

The S2DS reactor core generates fifty kilowatts of heat. In an operational device, the heat from the core would be transferred by a liquid sodium-potassium coolant to a boiler containing mercury. The mercury vapor would be directed into a miniature turbine for the generation of three kilowatts of electricity.

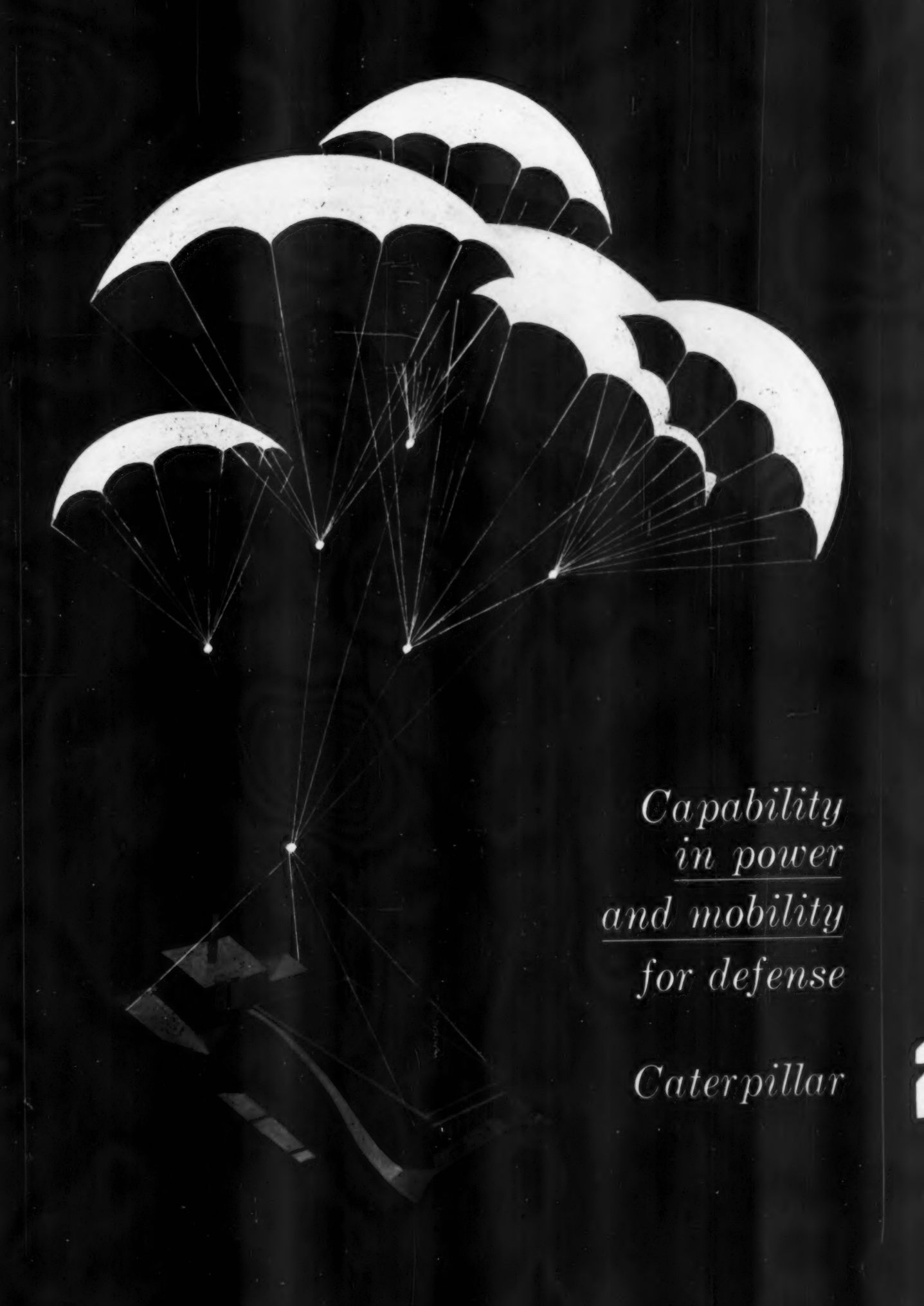
The reactor will be mated to its power-conversion unit for ground testing of the complete SNAP 2 system later this spring. After this testing program has been completed, a system with flight configuration will be mounted in a satellite nose cone for additional ground tests.



BURIED BUT ALIVE

Hidden in the earth, the Air Force Minuteman missile must remain ever ready. Though untended for weeks, months, even years, each of its thousands of components must function perfectly together if the button is pushed. This is the new order of reliability being fulfilled by Autonetics – designer of the Minuteman's critical guidance and control system.

Electromechanical Systems by **Autonetics** Division of North American Aviation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in power
and mobility
for defense
Caterpillar

Machine Weight: 70,000 lbs.
Ground Pressure: 4.4 lbs. per sq. in.

Horsepower: 500.
Pounds per horsepower: 4.3.
Designed and built for Ordnance.

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Wear rates established quickly and
accurately through use of isotopes.

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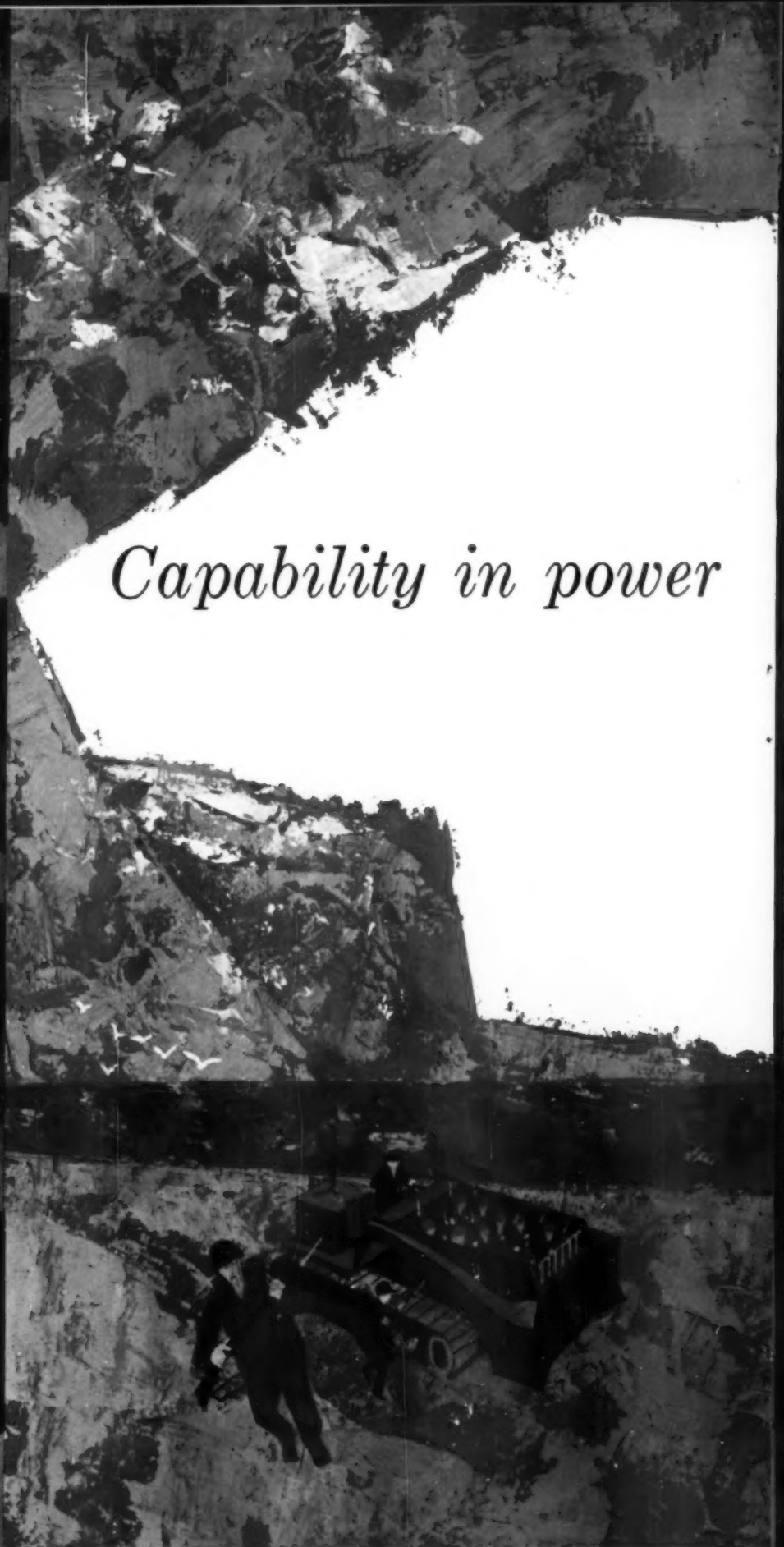

Capability in power

Caterpillar Capability in Research

Research of the components and vehicles we manufacture is only part of our research effort. It extends into materials and techniques used in manufacture, as well as lubricants in cooperation with major oil companies, tire materials and design with leading tire companies and many other areas affecting machine reliability, life, and performance. The objective: to improve the complete operating vehicle. Today, at Caterpillar, 1500 people are engaged in metallurgical, fluid mechanics, applied mechanics research, to cite a few continuing basic studies.

and mobility for defense

Caterpillar Capability in Development

Before designs are produced, three steps are taken: (1) design approach is proved by evaluating research findings; (2) preliminary production design is made to determine manufacturing and maintenance feasibility; and (3) final design is made to incorporate changes and improvements indicated by first two steps. In this way, military requirements are met under a controlled research, development, and production environment.

Proving grounds totaling 10,000 acres enable thorough testing of both military and commercial machines under all conditions of terrain and climate.

Caterpillar Capability in Production

Economical, quantity production of military equipment is assured with the machining, fabrication, assembly facilities, and manufacturing experience of Caterpillar. With rigid quality control at all phases, military needs are fulfilled with reliable products delivered on schedule. For further information about Caterpillar's ability to arrive at sound practical solutions for components and vehicles, write for Bulletin No. 40-20265, Defense Products Department, Caterpillar Tractor Co., Peoria, Illinois.

CATERPILLAR

Research-Development-Manufacturing for Defense

Washington, D.C.; Peoria, Illinois

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Founded 1919

A patriotic, educational, scientific, nonpolitical, and nonprofit-making organization of American citizens dedicated to scientific and industrial preparedness for the common defense

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Army photo

ROBERT S. McNAMARA

The Secretary of Defense

Defense Management

The new Secretariat is impressive in theory and in experience

THE problems facing the Defense Establishment of the United States are as changing as the daily headlines—but are far more consistent. Their solution, as in the past, continues to rest upon adherence to basic simplicities modified in the nonessentials in such degree as will adjust to the individual question of the moment. At the same time our defense stature and strength must be nourished and the instant readiness of all elements must be safeguarded.

Such thoughts are dominant whenever there is a change in the high command of our Nation. Each four years the opportunity occurs; during the past sixteen years since the cessation—we were about to say the "winning"—of the Second World War, there have been only two such major transfers. Now the country is at the beginning of a third. And again, the wise provision of the Founding Fathers is altogether justified: the military power of the United States is under civilian control.

IT would be easy enough to review those past sixteen years and to decry the mistakes and criticize the failures. With a deep sense of shame we would recall our disastrous destruction of history's greatest military machine in the second half of the 1940's; our shock at the tragedy of Korea—which is still with us; the vacillation, indecision, and often somnolent attitude of lawmakers and administrators.

At the same time there has been commendable progress and good leadership for the most part by both the civilian and military components of the Defense team. On balance, we are not weak—but neither are we strong; that is to say, we are not strong enough to face the deteriorating conditions which daily grow worse on the international front.

There are problems aplenty facing our new Defense leaders—some are inherited from years back, others are as recent as yesterday's symptoms from some distant continent of the globe. It is not a happy prospect; wishful thinking will not make it so.

Rather, the military strength of the United States today demands calm reappraisal, prudent decision based on the facts of life, and fearless determination to build our defenses where they are weak, weed out the waste and inefficiency, change where change will improve conditions—but never change simply for change's sake.

In other words, the simplicities must be reaffirmed, the defense dollar must be stretched, and our national-defense capability must be strengthened.

OUR new Secretary of Defense and his associates in the Secretariats have given ample evidence that they are well equipped to meet the problems of the moment with the wisdom born of successful experience.

Robert S. McNamara, the Secretary of Defense, the service Secretaries, and the military chiefs of the services—Army, Navy, Marines, and Air Force—are all men who know war at firsthand and who have attained rightful recognition in their respective professions. Our Commander in Chief himself has proved his bravery under enemy fire.

In the area of armament strength and progress none will give more vigorous help than members of the American Ordnance Association. Our Association, since 1919, has tried its best to inculcate in the minds and hearts of its members and of all their fellow citizens an appreciation of the ceaseless need for armament preparedness.

Nothing on the scene today, domestic or international, warrants a letdown in the slightest degree. Rather, the portents are more ominous than ever. Now is the time to look to our arms and not to be led astray by Communist trickery.

The new Secretary of Defense has been a member of the American Ordnance Association for a number of years. He, with other senior executives and engineers of the Ford Motor Company, thus has been identified with the Association's activities for industrial preparedness. The Association is proud that another head of the Defense Establishment in this regard is following in the footsteps of several of his predecessors.

Robert S. McNamara has had a meteoric career in education, military service, and in industry. Born in San Francisco, he completed his college education at the University of California from which he was graduated with an A.B. degree in 1937.

He received a degree of master of business administration from Harvard University in 1939. In the following year he became an assistant professor of business administration at Harvard, leaving that post for military service in 1943.

At the termination of World War II he had attained the rank of lieutenant colonel in the United States Air Force and was awarded the Legion of Merit.

He then became an executive of the Ford Motor Company, progressing through several advancements: controller in 1949, assistant general manager of the Ford Division in 1953, vice-president and general manager of that division in 1955, group vice-president of car divisions in 1957, and president of the Ford Motor Company in 1960. He was awarded the degree of doctor of laws by the University of Alabama in 1955.

Underground Warfare

While much emphasis is being placed today on the more spectacular weapons, not enough has been said about our new land mines and their potent ability to limit enemy mobility in the combat zone

Mark S. Watson

THE Army's tenacious insistence that modern warfare has more than one aspect, last year won an appreciably larger degree of congressional sympathy in the tangible form of procurement appropriations for weapons and equipment vital to the conventional or limited warfare which, we are increasingly aware, is more likely to occur than an all-out world conflict—however essential our readiness against the latter may be.

In the new Congress again there is reasonable expectation of still further authorizations of new-type equipment for a modernized military establishment which must have dual, rather than single, capability.

A great deal has been said and written of Army modernization through increased mobility, firepower, target-acquisition, and communications, and through the adjustments which such equipment calls for in tactics and appropriate field organization and command.

THE reading public accordingly has become fairly familiar with much of the more spectacular new equipment designed to advance these capabilities, such as the M60 tank and the M113 armored personnel carrier, the several new self-propelled guns and howitzers, the greatly improved light airplane, helicopters, and amphibians, and the almost-magic Signal Corps items.

Relatively little has been said of the new instruments of mine warfare. And this is odd because in highly mobile combat operations mine warfare, paradoxically enough, can be among the most efficient of all the means of furthering the mobility of our own fast-moving ground forces or of blasting those of the enemy.

Mr. Watson is a well-known military analyst and holder of the 1945 Pulitzer Prize for international correspondence. He is military correspondent on the staff of the Baltimore Sun.

Our veterans should know. In World War II our German foes' skill in mining was responsible for about twenty per cent of our own tank losses (in individual actions as high as forty per cent) and for an incalculable but probably far larger percentage of the time delay suffered by our task forces.

In Korea a few years later, the Navy's long holdup off Wonsan was due to a later enemy's skillful and wholesale use of mines in another medium.

Historically, nobody has employed mines more extensively or with greater skill than the Russians, particularly in relationship to battle-area mobility. It is Russia's standard practice to sow mines along both flanks of its advancing task force to assure protection for the combat element itself and for the following support elements. At a prolonged halt the front, too, is similarly protected, and the temporary mine field swiftly cleared when the attack is resumed—the recovered mines being carried on for the next requirement.

With this safeguard there is no need for diverting large combat forces to provide the conventional temporary flank protection, and the commander can push ahead with a task force of maximum size at high speed. Thus the mine is an essential factor in affording field mobility for a task force skilled in these tactics.

EQUALLY, it can be a potent factor in preventing enemy mobility for such an operation and can do so with minimum deployment of personnel. This is achieved, naturally, by the stealthy laying of mines in defiles and across traffic routes which the enemy's mobile forces would probably use in their own operations.

If that enemy unwittingly plunges into such a trap, his losses in men and equipment can be so crippling as to defeat his project. If he halts long enough to clear the mines he becomes the unlucky target for concentrated and inescapable bombardment. If he pulls away and marches around the danger area (if, indeed, the terrain permits a march-around) he loses invaluable time and forfeits the surprise which is essential in successful war.

As a temporary and economical but extremely efficient roadblock, the mine is in a class by itself.

There is no novelty about these prin-

ciples, but it is a lamentable fact that the United States Army too often has lagged in its recognition of them and in fully applying them, with unhappy results. Russia, on the contrary, has excelled in mine warfare for years and latterly appears to have pushed further ahead in applications, not only in devising new weapons and new counter-equipment, but in developing new tactics and in training a large percentage of key personnel in their use.

We still hear plausible tales of old-time emergency methods such as that attributed to Marshal Zhukov—clearing an enemy minefield by marching his own troops (or captured personnel) across the danger area on the commander's cold-blooded judgment that he would lose about as many men anyway if he stayed put long enough and thus exposed his halted forces to enemy bombardment. Maybe—but there are less costly ways of clearing a minefield.

THERE are four broad areas of mine warfare, and all of them are being explored by the U. S. Army Engineers (whose combat units are the principal but not the sole personnel in operations and whose own experts are a large factor in current research and development); by the Ordnance Corps (which, in providing the ultimate material, is necessarily active in research, development, production, and procurement here as with other military equipment); and by the Intelligence, Operations, and Planning elements of the Staff.

These areas are: (1) The mines of various types; (2) The means of placing them expeditiously and effectively; (3) The means of detecting them—both the enemy's and our own; and (4) The means of removing or destroying them.

Marked progress—in a few instances very marked progress—has been recorded since Korea. Some of the most promising new instruments are classified, and properly so, but there are a good many of the new or improved ideas in each of the four categories which can be discussed publicly with a fair degree of freedom.

But first it must be plainly stated that the improvement is moderate, by any reasonable measure. Some of the equipment which will be discussed hereafter in some detail quite plainly is no more advanced than equipment which we know the Soviets have possessed for several years.

Secondly, it must be just as plainly stated that the extremely efficient items we have developed to the point of readiness have not been produced, much less acquired, in quantity. Development and testing and evaluation are necessarily ahead of training and of quantity procurement. In this case they are far ahead, simply because the thrifty procurement program to which the Army has been restricted for years compels planners to spread purchases over a wide field of essential choices with extremely small purchases of any single items so unforunate as to be in the lower part of the priority list.

Mines and related equipment, it has been ruled under this doctrine, are to be acquired late in the day, on the too-familiar reasoning that when the emergency comes it will be time enough to buy and train. Meantime, the Army uses up old stocks of mines in its training activities. Almost everything on hand now is of post-1950 production, but very little is of 1960 vintage. There simply have been too many higher needs against which to apply the Army's severely limited procurement money.

The basic objective of mine warfare, whether in the time-honored defensive sense or in the aid to offensive operations which has been mentioned, is to harass and delay and divert enemy action. In the past, great masses of men called for large logistical effort, and in many cases there was time for devising harassment of large, slow-moving forces.

In the new warfare the emphasis is on mobility, with fewer men moving far more rapidly to accomplish the same ends. Mines and antimine equipment, therefore, must be handled in such a way as to match the new mobility of the opposing forces. The conventional ideas of Korea, a mere decade ago, need revision.

TODAY'S mines must be smaller, more easily placed, more effective, more easily recovered (by us, we hope, not by the enemy) less restrictive of our own (but not the enemy's) troop movements. Our techniques must channel the enemy into areas where our firepower can crush him and hopefully must try to prevent the enemy from handling us in the same way.

Our need is for light, easily placed, undetectable mines with wide lethal range, plus a magic way of preventing the enemy from using like types against us—a difficult set of requirements.

It seems clear that in future wars (by reason of the much more powerful firepower now available to most foes) there will be a greater employment of barriers and obstacles, including mines, than in the past. Our own use of them will be determined, presumably, by the value the command sets on barriers and the time available for setting them up—always assuming that we have on hand such barriers and a sufficient ability to place them quickly and well.

To maintain our own mobility against an alert foe we must create our own lanes of advance, without delaying our

Jeep-mounted detector automatically stops vehicle if it locates mine (Army photo).

task forces' forward progress. Our Infantry and Armor boards, as well as the Engineers, have been studying the means of placing mines rapidly—say on a 100-yard front in ten minutes—but speed is not the only requirement.

It is difficult to employ a means of fooling the enemy specialists without fooling some of our own nonspecializing forces. This means that rapid laying must be accompanied by rapid plotting and marking-off—by methods which are not here publishable, but the need for which, and for accompanying troop discipline, is far beyond such requirements in past wars.

IT takes no gifts of prophecy to see in all this the immensely increased requirement for that battlefield mobility by air for which Army planners have been pressing in recent years. An aerial mount by which to move a light task force to a nonmined area becomes indispensable; a very light but effective mine, which such a force can carry with it to protect its small area from being overrun by an enemy counterattack becomes an essential addition to its armament.

A mere mention of the new warfare's requirements makes self-evident the interlaced relationship of mines, mine laying, mine detection, and mine elimination. Some discussion of what we are doing in these four areas is necessary.

Mines.—Many of the mine experts among the Engineers (and they are the men who ought to know, as theirs are mainly the tasks of mine placing, mine detecting, and mine removing, along with that Corps' other large combat activities) have a feeling that, despite the ingenuity of delayed fuzes and selective timings, the old-time instant-pressure mine is the best in most respects. The more sophistication mines have, the more the complications and hence the more chances for error.

Development of the trick mines—such as those which quietly accept one or more passing pressures and then blow up when an enemy column is well committed to that route—continues of necessity, however. It is necessary, for safety's sake, to keep alerted to anything which an enemy may use. Also it is good, for our own purposes, to sprinkle a variety of mines, each responding to a different impulse and each resistant to one or more kinds of detection, in order to catch a careless enemy by one means if not another.

Both in antitank and in antipersonnel mines there are very large advances. The plastic types are lighter, hence more easily laid and, more important, harder to detect. The most important single new item in the latter field is the horizontal-blast mine, of which one can speak freely inasmuch as Russia had such a type during World War II.

Most mines our forces then encountered expended their pressure in all directions, much of it harmlessly into the ground, much of it straight up. The modern type channels the fragments in a fairly narrow horizontal path, thereby cutting a lethal swath over a much wider range. Such a mine has a far larger effect than the old types and hence can be used in appreciably smaller quantities, which is of prime importance in that the time and cost of mine laying is thereby reduced.

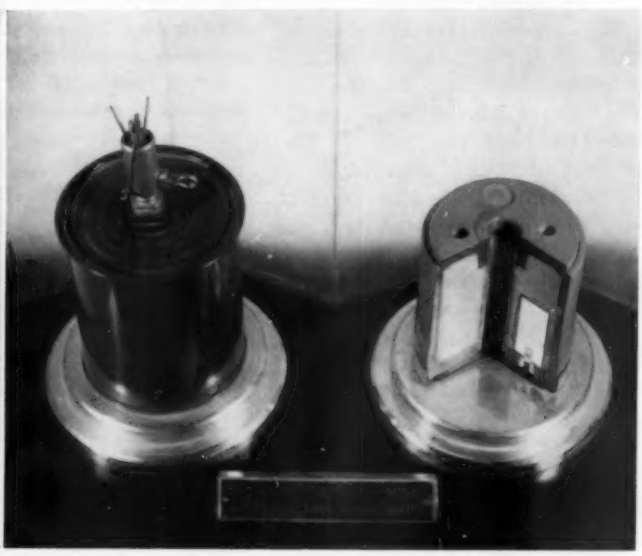
Ours is the Claymore (appropriately named for the famous Scots sword which in its way and time cut its own wide horizontal swath). It weighs only two pounds, yet blasts literally thousands of fragments in a path a mere six feet wide to a distance of one hundred feet. The M18 model was designed to cope with the enemy's mass attacks in Korea.

THAT model now is being phased out, to be replaced by the M18A1, ready for production. The new model has fewer parts, which means greater simplicity and larger reliability, with no sacrifice of effectiveness.

The purpose of the antipersonnel mine being to effect the greatest number of casualties, this matter of effective range is important. And so of course is the near nondetectability which plastic construction provides. The M14 (re-

Cutaway shows M14 antipersonnel mine.

Interior and exterior views of M16 antipersonnel mine (Army photos).



placing the old M3) emphasizes this last virtue, with no metal whatever except its tiny firing pin; if it causes only one casualty, it at least hurts the morale of all about him.

The new M16 (replacing the old M2) emphasizes range. It cannot be nonmetallic because its destructive power is in its metal fragments, but what it sacrifices in detectability it gains in lethality. This "bounding-mine" type, when subjected to pressure from treading or kicking or trip wire, is literally sprung into the air two or more feet depending upon the method of laying. There it explodes with far wider effect by being waist-high, and is effective against several men rather than one.

Today it is available in quantity, and on the bird-in-hand principle may be thought of as more useful right now than the more sophisticated weapons which are developed and tested but not yet supplied to field forces. It is necessary to distinguish sharply between this M16 and the much more effective Claymore M18. The latter is not a replacement, but is a new idea altogether, with no real predecessor.

In the realm of the antitank mine it is possible to record a notable advance in the M21, which provides a true quantum jump. Our World War II antitank mines simply did not have the stuff, unless an extra charge was added. Despite the economy budgets which followed 1945 and gravely hampered the Army's postwar research and development programs as well as the actual procurement of weapons, we did have the M6A2 and the M7A2 for use in Korea. They were effective against light tanks, and, as was true of our World War II types, could disable a heavier enemy tank if they actually hit either the tank track or an idler.

The M6A2's larger successor, the M15, has a heavier blast and will certainly immobilize either a heavy or medium tank. It has the virtue of being rapidly emplaced by use of our new mine planter, of which more later. It is metallic, which means that it is detectable by magnetic means.

THE still newer M19 is nonmetallic and its 21-pound explosive package (compared with the 10-pound type in its Korean war predecessor which had to be linked with an added charge to defeat a heavy tank) will do a good job of disabling.

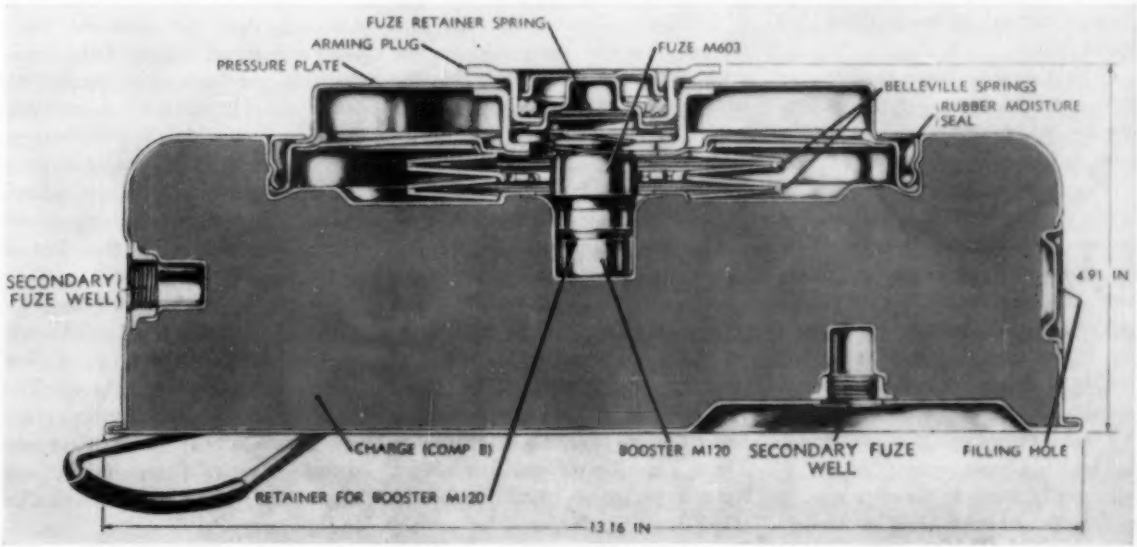
But the still newer M21 is something to cheer the troops. Its explosive charge is but 10½ pounds in a total weight of 17½, but it is so placed as to drive upward at high velocity a saucer-shaped disk which, by the so-called Misznay-Schardin principle, actually perforates the belly of the enemy tank and then, by fragmentation, can be counted upon to knock out the tank's occupants and in most cases to explode the tank's own ammunition. That tank is not merely immobilized; it and its crew are permanently out of business.

The M21 mine is much lighter than its predecessor (17½ pounds versus 31 pounds) and hence easier to carry and to sow quickly; yet it is enormously more potent. It is our first really to destroy an enemy tank rather than to disable it and allow our artillery a chance to knock it to pieces before the enemy could recover his vehicle.

The M21's immense power permits sowing it, too, with less density, and hence is a further aid to rapid sowing and to easing our own logistical problems. It seems to be as notable a gain in antitank mining as the Claymore is in the realm of lethality to personnel.

Mine Laying.—Primitive methods of mine planting are still useful in many an emergency and in fact necessary in the case of certain mines for which mechanical planting is not yet adapted. That is, many a troop column has been saved from enemy attack by the simple means of hauling pressure mines forward in an open truck and kicking them off through the tail gate, to be righted and fuzed by Engineer troops running behind the vehicle. Some of the newest also require such precise fuzing that the hand method is still required. But where a simple mechanism is feasi-

Interior workings of the M15 antitank mine, with fuze M603 installed.



ble, it is a great time-saver when time is important.

That is where new mechanical mine-planting equipment comes into usefulness. Loaded with the M6A2 or M15 mines in a vertical rack from which the mines are released one by one to slide down a chute into loading position, this big vehicle moves on course, its plow turning up a deep furrow, letting the mine slide into it, and closing the furrow as it moves on. It will plant ten a minute.

The main problem in this mechanized operation is to site and record accurately, so that the information will be instantly available to our own near-by troops for their own safety and also to the detachment of Engineers engaged later on in ultimate recovery of unexploded mines.

AS an aside, it might be mentioned that something like 19,000,000 mines were planted in North Africa 2 decades ago, and fully half of them are still there—which explains the grim jest that whereas from time immemorial the proud Arab male used to walk in advance of his several wives, he now permits them to walk ahead of him.

We also have a plain bulldozer mount, which digs a hole at stated intervals, a following pedestrian soldier dropping a mine into each hole and covering it. We also have the familiar earth auger for hand operation. In the case of types that need no hand fuzing, mines can be sown by helicopter—a valuable method for troops when they are in a hurry.

In all cases, tonnage is a problem, and this is particularly so with today's helicopters which have limited lifting power.

There are many considerations to worry the planners. If we are going to recover the mines ourselves, should we not make them easy to detect? The answer, of course, is No, for their main purpose is to harass the enemy, and we do not wish the mines to be easy for him to detect. We could make them self-neutralizing after a period of time, but that is expensive.

There is a great premium on having a variety of mines in the same area, so as to baffle an enemy searching for only one kind; that is, some antitank and some antipersonnel, some metallic and some nonmetallic, some straight pressure and some complex.

Mine Detection.—We have an obvious need for better detection apparatus. What we have ingeniously developed is effective against World War II types, but defensive mechanisms must keep pace pretty well with radical betterments in the offensive armory. This applies particularly to a remote-detection means which, once in hand, would be of infinite value in rapid movements past suspected dangers. Some degree of "remoteness"—safer at least than the foot-soldier's tread or the tank's blind movement forward—is afforded by the improved jeep-mount, six feet wide, rolling on three rubber wheels. This detector search head, pushed ahead of the jeep, detects a metallic mine and automatically halts the vehicle to permit someone to dig up the mine and disarm it. Two of them, obviously, will clear a twelve-foot path. Proved but not yet authorized for purchase is a transistorized version of the portable metallic mine detector weighing half as much as its predecessor (AN/PRS-3) and of such simplified construction that the man carrying it can correct most malfunctions.

More difficut to operate in its present form but marking an important gain is the AN/PRS-4, which detects nonmetallic mines. Unfortunately the detection principle utilized also enables the AN/PRS-4 to detect cobblestones and old tin cans and plain voids in the earth, so that it rouses many a delaying false alarm. The search for swifter detectors is endless.

Mine Eliminators.—The British in World War II used a huge flaillike arrangement, which employed long metal whips to flog the earth in front of a vehicle and to explode hidden mines harmlessly. Our forces did not like it and our research efforts have been in other fields. There is a roller of articulated disks, likewise pushed in front of a vehicle, which has been developed but not authorized for manufacture; the Russians have used something of this type. There also is the familiar "snake," pushed lengthwise forward for one hundred yards or so and then set off so as to explode concealed mines in that path and allow movement forward for that limited distance. This device worked successfully in breaking from the Anzio beachhead.

We have on occasion used artillery fire for like purpose, but the cost of such an operation which calls for extremely heavy concentration is thought impractical, although the "walking-barrage" in front of an infantry attack itself partly accomplishes this very important function.

But the need remains for the sure, remote detector and accompanying destroyer as the only combination with any real promise of rapid progress by our troops. Speed, one must bear in mind, is the first need of the modern army.

Some modest progress already is recorded. The snake (M3A1) with its ability to clear a path is followed by the M157 which works on a similar principle but more effectively clears a wider path for vehicles. Under development is yet another, propelled a further distance forward by a low-power rocket and having the added advantage of overflying a terrain barrier which the snake process could not pass.

AS is so often the case in the design of military equipment, compromise is necessary. And that does not mean solely wth regard to costs. Reliability is desirable, and that suggests simplicity—but on the other hand it is necessary to fool the enemy soldier, and that encourages complexity. The struggle between the offensive weapon and the defense against it is as endless with mine warfare as it is with every other field of armed combat.

But the fact is that until lately we have been novices in this field of weaponry and tactics, and we have a great deal of lost ground to make up. Too many of our people still are unaware of the role which mine warfare—designed in radically new forms—may play in the wars of mobility which lie ahead of us.

Disarmament—and After

Among the principal obstacles to a worldwide reduction of weapons are the avowed intentions of the Communists to conquer the earth and the obvious difficulty of limiting internal security forces

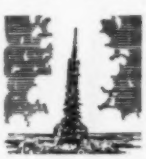
Maj. Reginald Hargreaves

IN October 1959 the United Nations General Assembly's main Political Committee adopted an 82-nation resolution calling for measures aimed at consummating "worldwide total disarmament in the shortest possible time."

In Geneva, in April 1960, as a particularly fruitless session of the Ten Power Conference on Disarmament resolved to go into recess, M. Jules Moch, France's veteran representative, was asked if he felt discouraged. "Even after nine years of experience in disarmament negotiations," he replied, "I never give up hope."

"And how many years of experience do you expect to have?" his questioner persisted.

M. Moch smiled cryptically. "For me, I don't know," he replied, "but I'm thinking of keeping the job for my grandson. He is now eleven."



M. Moch is obviously well versed in the sorry history of the League of Nations Permanent Armaments Commission, the sole outcome of whose 1931 agreement to convene a World Disarmament Conference was the wholesale rearming of Hitler's Third Reich.

In effect, the German Führer, in his campaign to restore Germany's erstwhile position of consequence in the concert of Europe, took the traditional line that a nation's influence in international circles can only carry weight if it is known to argue from strength.

Major Hargreaves, a retired officer of the British Army, is a well-known historical writer and a frequent contributor to ORDNANCE *magazine.*

That, however, was before the development of the terrible weapons in the atomic armory. Owing to their existence, the contemporary urge to adopt "measures leading to the goal of general and complete disarmament under effective international control" is founded on quite a different impulse from that animating the interwar negotiations.

In the 'thirties the prevailing hope was to avoid a repetition of mass slaughter, by the weapons then available, similar to that which had characterized the conflict of 1914-1919. Today we face the possibility that war between the free world and the forces of Communist imperialism might well entail something little short of race-suicide—and a new Dark Age for such few as survived the apocalyptic holocaust.

The terror deadlock is so precarious and the restraints on political irresponsibility so fragile, that the pressure to adopt some drastic means of averting catastrophe has become importunate. Man's ingenuity having outstripped his sanity, elementary precaution demands that his imbecile inconsequence be constrained in an internationally fabricated strait jacket.

The greatest dread being of nuclear weapons, the first item on the Ten Power Conference agenda is to work out an agreement governing the best method of impounding and harmlessly destroying such stockpiles of these terrifying engines of war as the respective sides reveal to be in their possession. The natural corollary to any agreement to "ban the bomb" arrived at between Soviet Russia and the West is mutual inspection to ensure that no surreptitious attempts are made to evade the terms of the compact.

BUT—as any survivor of the post-1918 Control Commission in Germany would give unqualified assurance—to carry effective inspection into execution is a process that fairly bristles with difficulties—and also with opportunities for evasion on the part of any power bent on falsifying its obligations. In the 'twenties, despite Germany's complete prostration, it was found quite impossible to bring about the degree of disarmament on which the victor nations had insisted.

Of the 96,000 men comprising the force permitted to remain under arms for the purposes of internal security, 40,000 were highly trained noncommissioned officers capable of furnishing the framework that, at any moment, would ensure rapid and orderly expansion. Furthermore, there were 150,000

Schutzpolitzei, armed—and trained—on paramilitary lines.

In addition, the various Friekorps and such veterans' formations as the Stalhelm represented war-experienced and firmly disciplined bodies of ex-servicemen upon whom any "patriotic" administration could call with complete assurance of a ready response. The General Staff—whose continued existence had been forbidden by the Treaty of Versailles—was camouflaged as the Truppenampt, or Troop Office, and in this guise carried out its functions as heretofore.

MYRIADS of weapons remained concealed; it was even found impossible to run to earth and scrap the long-range gun that had shelled Paris, or the 42-cm. siege mortar known as *Die dicke Bertha* which had pulverized the French and Belgian frontier defenses at the outbreak of hostilities in 1914.

After the Treaty of Rapallo in April 1922, Soviet Russia freely permitted the training on Muscovite soil of those technicians, such as tankmen, submariners, and air force personnel, as had fallen under official interdict.

If an ex-enemy were able to evade so comprehensively the dictates of the conquering powers, how much more easily could subterfuge and elusiveness be practiced where inspection, operating in an ostensibly friendly country, was under Agag's stultifying obligation at all times to "tread delicately." With such a shackling handicap, the efficacy of any watchdog inspectorate would be reduced to something not far removed from zero.

Fundamentally, of course, the whole problem turns on the degree of sincerity that can be attached to Soviet proposals for scaling down to the vanishing point her quota of world armaments and the fighting services she has trained in their operations, as well as on the degree of good faith the Soviet leaders could be relied upon to evince in carrying out their particular share in a worldwide undertaking.

At the moment is it reasonably safe to assume that the men in the Kremlin are generally averse to war on a global scale. However much the shifts and turns of policy may have dictated the denigration of Stalin and the denunciation of the "personality cult," the words of Lenin are still taken as gospel and constitute the basis of Soviet imperialism's thinking. And in his testament the archpriest of world Communism stated, at the Fifteenth Congress of the Communist Party of the Soviet Union, held in December 1927:

"A great deal of the matter of our construction depends on whether we can succeed in postponing the war with the capitalist countries, which is inevitable, but which may be delayed until the proletarian revolution ripens in Europe or until colonial revolutions come fully to a head, or, finally, until the capitalists fight among themselves over the division of the colonies. Therefore for the time being the maintenance of an appearance of peaceful relations with the capitalist countries is an obligatory task for us."

This without prejudice, of course, to furthering the downfall of the said capitalist countries by subornation, subversion, the fomenting of industrial unrest, and the clandestine support of such wasting "cat's-paw" conflicts as those that occurred in Malaya, Indo-China and Korea, and continue in Algeria.

Communist Russia's over-all policy was enormously aided by two entirely fortuitous postwar developments: (1) the vacuum in Europe created by the premature disbandment of the Western nations' armed forces which enabled the Soviet leaders to embark unchallenged on a major program of expansionism, and (2) the success attending the undiscerning anticolonialism campaign, which handed over to the Communist propaganda agencies an enormous mass of ready-made dupes, to be sedulously groomed in virulent antiwesternism.

The outcome of these incredible follies is plain for all the world to see. Nine freedom-loving nations have disappeared into the Soviet maw. At the same time, without any discernible claim to ethnic origin, a common language, religion, culture, or political history, thousands upon thousands of individuals are constantly to be heard bellowing such amorphous slogans as "African!" "Arab!" "Asian!" without any particular idea of what they mean, or to what they lead. (The Arab world provides a striking example of the confusion to which inchoate "nationalist" sentiment gives rise. For no group of neighbors could be more hoplessly at odds than the members of the Arab League, who are agreed only on one thing—hatred of the West.)

At the outset these parrot cries serve no other purpose than to epitomize a general feeling of girding antiwesternism. Under the expert handling of Russia's emissaries, however, "nationalism" becomes the cloak beneath which Communist imperialism shrouds its sinister designs.

That kind of subversive activity would be entirely unaffected by a global disarmament agreement, and, if not competently dealt with, in the long run it could be relied upon to achieve the Kremlin's objectives far more successfully than an overt appeal to arms.

THE success attained by exploiting "nationalism," or any other vaguely definable but keenly felt urge that can be worked up into a useful antiwestern, anticapitalist sentiment, is witnessed by the fact that whereas in 1939 less than one-tenth of the world's population adhered to Communism, nowadays responsible authorities put the aggregate at one-third. And it is still growing! (Oddly enough, the only country to show an opposite trend is Yugoslavia, where there are 6,400,000 members of the Socialist Alliance as against 800,000 belonging to the League of Communists.)

This aspect of the perennial struggle between the engineers of Communist expansionism and those who oppose them has an oblique rather than a direct bearing on the problem of multilateral disarmament, a process which at the moment the Kremlin has its own reasons for endorsing. Malenkov's supersession by Khrushchev substituted the latter's program, aimed at the expansion of heavy industry, in place of the former's plan to increase the volume of hungrily besought consumer goods.

In addition, Khrushchev has another

tremendously onerous project on his hands in his "virgin soil campaign." By the terms of this intimidating commitment he is pledged to reclaim some 13,000,000 hectares of uncultivated and hitherto unproductive land in the Volga region, in the Urals, in Siberia, and in Northern Kazakhstan—an undertaking that has hung fire badly owing to sheer lack of manpower to carry it through.

A massive scaling down of the Russian armed services would release an enormous labor force for the furtherance of a project upon whose successful issue Khrushchev's whole standing with the country in general, and the Party in particular, can safely be said to depend. If it proved successful, his position would be consolidated past hope of effective rivalry.

Should he fail, he would inevitably confront the likelihood of demotion, such as Malenkov underwent.

It is possible, therefore, that Russian cooperation—genuine up to a point and for a limited interim period—could lead to a radical scaling down of armaments and the professional forces trained in their use. At this juncture the various parties to the agreement would be left with the final problem —that of determining what could fairly be regarded as constituting an appropriate organization to ensure internal security in the respective countries.

This is the crux of the whole question. For were the ratio to be determined on a basis of population plus area, Soviet Russia would be in a position to insist that, with responsibility for the control of her enormous land mass containing a population—including the satellites—of over 330,000,000, any reduction in her existent internal security forces would be out of the question.

MOST law-enforcement organizations consist of police and rural gendarmerie, very lightly armed—if armed at all—with a few hand weapons. Moreover, in most law-abiding lands their number in relation to the total of inhabitants is negligible, since, to date, there have always been a country's armed forces to come to the aid of the civil power in the event of an emergency.

Dictatorships, however, have to maintain themselves by force rather than by ready cooperation. It follows that with no other nation are there so many police in proportion to the total of the population as in Soviet Russia and her dependencies.

Apart from over 1,000,000 agents, informers, and *agents provocateur,* the uniformed branch of the M.V.D. numbers 2,000,000. Of this huge body of men the total of the Special Security Force is put at 750,000, with its own aircraft, tanks, and autonomous communications system. It is, in effect, a *corps d'élite* far better paid, housed, and generally looked after than the Red Army or the police.

In addition, there would be the Volkspolezei in East Germany and the corresponding forces of suppression maintained in the other satellites.

With Europe totally disarmed and in possession only of negligible, lightly armed internal security forces, the whole Continent would lie at the mercy of what, by the mere change of cap badges, could be transformed into the most powerful "conventional" force.

As for Russia's readiness, as well as her capacity, to embark on secret weapon production, a recent study by the Johns Hopkins University research group argued that Khrushchev's "total disarmament" proposals should be rejected on the grounds that their acceptance would permit a violator to gain supremacy through "concealed production of relatively few weapons."

Nor does the fear of a duplicity that would authorize secret rearmament while ostensibly disarming lack evidential justification. For Lenin himself, in a speech at the Third Congress of the Young Communist League, October 2, 1920, made it quite clear that "Communist morality must be independent of any other morality, quite different from the bourgeois morality, and entirely subordinated to the class struggle of the proletariat."

That his successors faithfully abide by this unscrupulous, opportunist doctrine is witnessed by Khrushchev's uncompromising comment of 1955: "Anyone who mistakes our smile for a withdrawal from the policies of Marx and Lenin is making a great mistake."

The lamentable truth is that over the past few years far too many people have been indulging in a pernicious bout of wishful thinking. The general public has yearned for a relaxation of tension, and consequently the politicians have emphasized everything conducive to such relaxation and minimized everything that pointed the other way. The more the public was placated, the greater grew the appetite for reassurance. And so on *ad infinitum.*

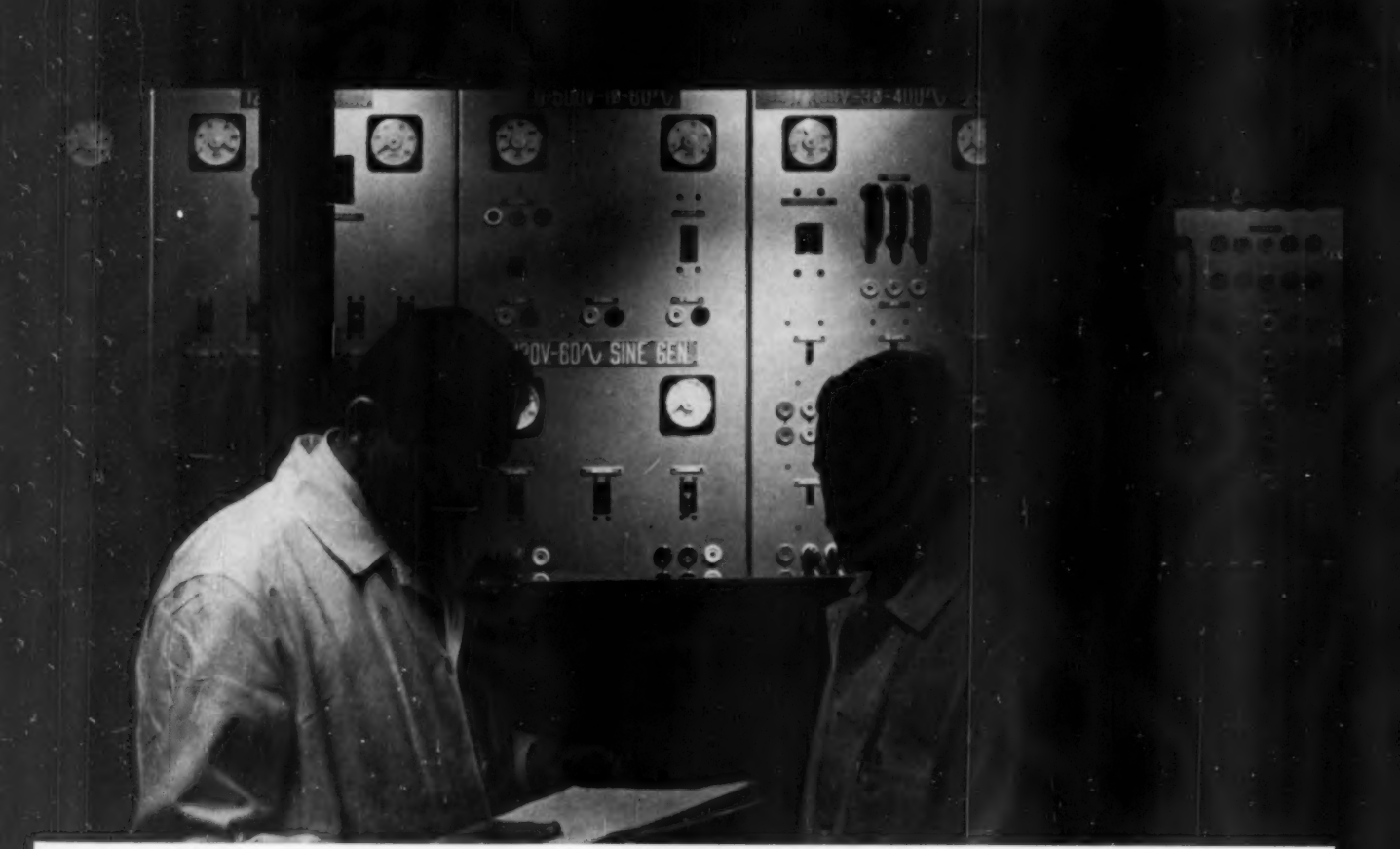
Tibet might disappear behind the steel-reenforced Bamboo Curtain; the "Trojan horse" of Kerala welcome the violation of India's northern and eastern frontiers; Laos might be infiltrated by active Red agents and the Middle East teem with them; thirty-one Hungarian Freedom Fighters might face execution after three years of brutal imprisonment; Khrushchev might serve fresh warning of Communist intentions in an American periodical for all the world to "read, mark, learn, and inwardly digest."

No matter—the wishful thinkers still continued to babble of disarmament.

IT follows that since there are more line-of-least-resistance wishful thinkers than resolute, clear-eyed realists, there is every possibility that the Ten Power Conference—or some successor —will end by committing the Western world to a process of progressive disarmament that would leave it "like a fowl trussed ready for the spit."

In the process, moreover, Red China would achieve that recognition by the United Nations Organization hitherto so sternly denied. For a world agreement on disarmament that did not include Mao's signature would resemble nothing so much as "Hamlet" without the Prince of Denmark.

The only thing that Communist imperialism understands and respects is strength. It enslaves all those who cannot confidently fling back the gage at its feet. Armaments may constitute a mighty heavy burden; but a rifle and pack are far more easily borne than the oppressive weight of a helot's chains.



Industry Studies Defense

Dr. George L. Haller

SCIENCE and technology came to the battlefield at Hiroshima, and defense planning has never been the same since. The problem of national strategy no longer is concerned principally with the concept of military mass production. A new factor has to be considered in military planning, and this factor is made up of the potential of the Nation's scientists to innovate with such an order of magnitude that the balance of power is either always equal to or ahead of the technological war-making potential of those enemies who have promised to bury us.

Whether industry likes it or not it is forced to assume a role in defense planning. There are many opinions, however, as to what this role actually is. What this article shall attempt to do is describe some of the problems industry must face up to if it is to define its role in defense planning.

Industry has come to recognize that no longer can it merely wait for the defense-serving agencies of the Government to define the weapons that will be needed to defend the Nation. Due to the technological complexities in the design of modern weapons, industry *must* program the work of the laboratories to agree with the potential political and environmental influences that will govern the use of our weapons in the wars of the future.

But do not mistake this planning and study by industry as an infringement upon, or usurping of, the planning and decision-making roles of the Government. Industry must do this planning if it is to conserve its limited resources. Industry must zealously commit these resources so as to bring about the most expeditious and economical research, development, and production of military hardware.

Throughout industry there is a growing trend toward taking an educated "look ahead"—to sense the technical demands of total defense, not one or two years ahead, but five, ten, and even fifteen years into the future.

In General Electric, for example, full-time experts (physicists, economists, psychologists, scientists, and experienced military strategists) study and analyze the geopolitical and military situations of the world as they apply to the defense of the United States in the fields of applied military technology, and the social and physical sciences. These people are concerned with the synthesis, description, and preliminary specification and evaluation of preferred systems to meet requirements which are foreseen in future military operations and which reflect advanced states of the arts in the engineering disciplines.

Using this material in the form of

well-documented reports, it is possible for our top management to explore whole areas of future research and production activity which we should include, modify, or eliminate from our future business programs. As pure military defense business becomes increasingly just one of several aspects of the total defense effort, this approach can do much to pave the way for the transition into greater nonweapons activity.

As a case example of our planning approach, I have based the analysis of future world conditions and situations, which follows, upon one of the reports recently issued by our full-time staff of researchers.

THE first consideration that any industry-military planning must be concerned with, is the aspects of international power.

An examination of the investigations upon which our planning is based indicates that the pattern of competition between the United States and the U.S.S.R. is presently shifting and that in the immediate future, as well as for the long run, the reliance will be less upon military weapon systems and more and more upon the use of economic, political, and psychological strategies to maintain and further the prosecution of the cold war.

This is evident in the use by the Soviet Union (as well as by its Red Chinese allies) of economic aid programs for underdeveloped areas. It is also clear that the technological advances being made by both the United States and the U.S.S.R. have psychological and political overtones that do not escape the attention of the rest of the world.

The implications here for planners in our own country will have considerable impact upon the appropriations for research, development, foreign aid, weapon systems, technical assistance, and many other means employed to hold our position as the leader of the free world coalition.

The temptation to see in current or recent events the signs that point clearly to possible future courses of action is great. Such happenings as Russia's technological advances, the visit of Chairman Khrushchev to the United States, or the trip of President Eisenhower to Europe some time ago, the proposition offered by General de Gaulle for the settlement of the Algerian struggle, the future of the "welfare state" in Great Britain, the anti-American riots in Japan, the failure at the Summit meeting in Paris, and Khrushchev's unhealthy interest in the United States presidential election and his violent display at the United Nations—these and many more occurrences of recent times give clues to the future, but they cannot help the planner quite so much as he would wish. What is needed, of course, is perspective—based upon research and a long experience of relating the happenings of the past to the prospects for the future.

Along with economic potential, the planner must also factor in political stability when he forecasts the international climate.

Within the influence base, political stability occupies a central position. The term suggests the acceptance of the government as the legitimate supreme authority by the socially mobilized population. Decisions of the government take priority over family, clan, caste, guild, religion, or region in such a way that rapid social change can take place without disruptive civil strife.

Political stability, therefore, includes the notion that ruling groups deliberately govern in such a way as to avoid the alienation of important sectors of the population—for example, the army, the students, the displaced urban workers, the peasantry being mobilized for modern life, and others.

Political stability has significance apart from that suggested in its consideration as a variable in the influence base. In the period from 1961 to 1975 the degree of stability must be weighed heavily in any assessment of the tension areas in which rebellion or aggression may be anticipated.

A country lacking an efficient political organization will normally offer a more tempting target to attackers, who can assume a weakened will and ability to resist. In general, an attack led or supported by the Communists becomes more probable where political stability is at low ebb.

During the period 1961-1975, the scientific capability of a nation will become an increasingly important element of its influence base. As nations progress from economic underdevelopment to industrialization they will endeavor to build their scientific capabilities to relieve their dependence on outside sources for scientific and technological support, to promote their economic growth, and to enhance their national security and pride. A necessary condition for achieving a scientific capability is the education of individuals in science and engineering. Thus, in forecasting future scientific capabilities for nations, one must assess current and projected educational programs.

Turning from traditional (*i.e.*, agricultural) and transitional (*i.e.*, where growth potential is in evidence) societies, where there will be little in the way of increase in scientific capability from 1961 to 1975, an estimate of the prospects for mature and high-consumption nations can be made.

IT is evident that during the period 1961-1975 the United States and the U.S.S.R. will maintain their supremacy in the area of scientific training from a numerical standpoint. In 1957 both nations had over one million persons employed as engineers and scientists. Not only did the United States and the U.S.S.R. markedly exceed the rest of the world in absolute numbers but also in the proportion or ratio of engineers and scientists to the total labor force.

It is important to stress that sheer weight of numbers is not the only consideration in assessing scientific capability. A nation with a large total population and a comparatively low number of trained individuals, such as China, may have rapidly increased its scientific and technical personnel in recent years by a forced-draft process without attaining the quality levels prevalent in the United States, U.S.S.R., and Western Europe.

Dr. Haller is vice-president and general manager of the Defense Electronics Division of General Electric Company, Schenectady, N. Y.

In the interest of brevity, I have elected to by-pass some of the lesser—but nonetheless important—factors which the planner must consider, such as the capability of selected nations to produce atomic weapons, an analysis of external variables governing power diffusion, and the influence of trade and aid on geosociopolitical environments.

All this leads to two main considerations in industry planning for the future: (1) factors influencing United States policy decisions and (2) the effect of a changing environment on the military planner.

Given the fact of the diffusion of power in the world of 1961-1975—with its implications for the role the United States may play in that period—what are some of the choices before American policymakers today and in the near and more distant future? Any delineation of choices must be based upon some agreement as to the continuing goals of American foreign policy. For purposes of this discussion, it is convenient to accept a series of propositions.

The fundamentals of American foreign policy will remain, as they have for nearly two centuries, the same: the preservation of the territorial integrity and the political independence of the United States, the safeguarding of the freedoms of the individual American, and the advancement of the cause of peace throughout the world.

BY building upon this base, it should be possible to outline several choices. Reduced to simple terms, three such choices are these:

1. To accept the fact of power diffusion and to try to accommodate our policies to the changed world of tomorrow on a "play-it-by-ear" basis.

2. To disregard the fact of power diffusion and attempt to maintain a position of isolation in the hope that our demonstrated riches and our national ingenuity will permit us to ride out the storms of the years ahead.

3. To attempt to accelerate or delay the diffusion of power wherever it is possible to do so, in the hope that such controlled actions will allow us to determine the pace of our reactions in keeping with our resources and requirements.

Ideally, the American policymaker would say that Course No. 1 offers a dangerous alternative in that a "play-it-by-ear" strategy puts it in the power of our adversaries to call the tune. Too many times in the past our policymakers have been figuratively "tone deaf," and our strategy has tended to follow the piper over the hill to oblivion.

But occasionally we have been quite successful in employing a "wait-and-see" philosophy in international affairs and have not suffered by our hesitancy. So we might be tempted to adopt Course No. 1 and trust in our inherent good fortune and our native acumen to keep us ahead of the game.

This particular course, which some commentators insist the United States has been following since the appearance on the world scene of the U.S.S.R., I believe would lead the American nation into a hopeless competition. And this competition would be marked by a need to respond in kind to every stimulus provided by the U.S.S.R., its satellites, and Red China. Our nation would be constantly in a precarious position, dependent upon the probes and withdrawals of a strong, if not always clever, competitor. Because the international situation has changed greatly since the time when "play-it-by-ear" was a possible strategy, the United States faces the need to do more than guess from where and how the next challenge will come.

It would seem equally true that Course No. 2, the policy of isolation, should be rejected by the American policymaker as a sure invitation to national suicide in the world of today. However, we are not too far from the time when an American Congress, just before Pearl Harbor, was all but convinced that something like Course No. 2 was the way to salvation. Nor should it be forgotten that sentiment in favor of isolation was strongly represented in the disarmament measures of the 1920's and the various neutrality acts of the 1930's.

Under certain possible (though not probable) conditions, such a belief might once more prevail among a number of legislators and a large segment of the public. This would be especially true if a measure of international disarmament were achieved, either under United States auspices or by a multilateral arrangement among the larger powers.

Aside from these possibilities of some device for the reduction of armaments and of military forces, the declining fortunes of our postwar alliance system and the inflationary aspects of our economic situation might add considerable influence to moves toward withdrawal from the overseas commitments we now honor.

All things considered, however, it is more than likely that the United States will not adopt a course that resembles in any large degree the alternative labeled Course No. 2. The events of the years since 1941 with respect to power diffusion and the extension of atomic capabilities indicate that the United States is inextricably involved in world affairs.

To attempt to withdraw to a "Fortress America" type of diplomacy, while it might prove popular with a segment of the American public, would endanger the security of the Nation if there is any reality in the depiction of the future world as our planners forecast it.

COURSE No. 3, the attempt to accelerate or delay diffusion of power, has its attractions and pitfalls also. It would demand cleverness and foresight and a courage of the highest order on the part of policymakers, as well as a willingness to take risks that might endanger the whole fabric of our foreign policy. And while we as a power were doing what we could do to slow or speed the diffusion process, we could be certain that our adversaries were playing the very same game for their part.

Thus we would have two main tasks on our hands—to detect the course of their actions and to carry out the necessary actions of our own to achieve our objectives. Nevertheless, we have sometimes been able to do this on a small scale successfully, and it should not be beyond the ingenuity of Americans to operate efficiently on a larger scene

where the stakes were greater and the risks more acute. By manipulations of aid, trade, political, military and ideological forces, the United States could appreciably affect the pace of power diffusion in various parts of the globe.

The big question is, first, would we want to do this; and, secondly, have we the determination and talent needed? It seems accurate to say that, in many senses, our national leadership is becoming aware of the potentialities in just such a course of action.

IN planning for either the short or the long range in attempts to achieve national objectives and international goals, no course can be regarded as totally satisfactory or without perils. The factors described as contributing to the diffusion of power in the world impede or accelerate progress at frequent intervals.

However it would seem probable that the United States is more and more systematically committed to gear its operations—especially in the underdeveloped areas of the world—to the creation of political stability which will be able to induce and control social change; but in so doing the United States is not committed necessarily to the creation of democratic regimes.

There must also be considered the consequences of Khrushchev's strategy of persuasion in which he directs a propaganda assault designed to gain the greatest possible effect from the impact of Soviet scientific development together with programs for economic and military assistance and cultural exchange.

The current Soviet Seven-Year Plan (1959-1965) in its concept and motivation derives in good part from Khrushchev's conviction that that system will eventually prevail which—owing to superior economic performance at home—exerts the greatest power of attraction on underdeveloped and other countries.

Therefore, it is believed that the shift of emphasis is already under way on the part of the Soviets, and we must look toward plans of our own to meet the challenge of this change without diminishing the requirement for military research. In other words, we must "keep our powder dry," while devising alternative courses of action to ensure that we are not shut off from our sources of strength in the world—our belief in the dignity of the individual and in his freedom of opportunity in keeping with his talents.

WHEN we screen all the information that our planning has pulled together, we find that the role of industry in defense planning is based on a 5-step program.

1. Our first step in this program takes into consideration that we must base our plans on technological advances which are in being and which can be planned intelligently for the future.

2. We must couple such information with the defense requirements set forth by the Department of Defense. Our interpretation of this information must factor in a background concerning the social, economic, and geopolitical influences which produce conflicts among nations and which will determine the atmosphere and attitudes which will affect the way defenses will operate.

3. We must make our plans and studies available to the Department of Defense.

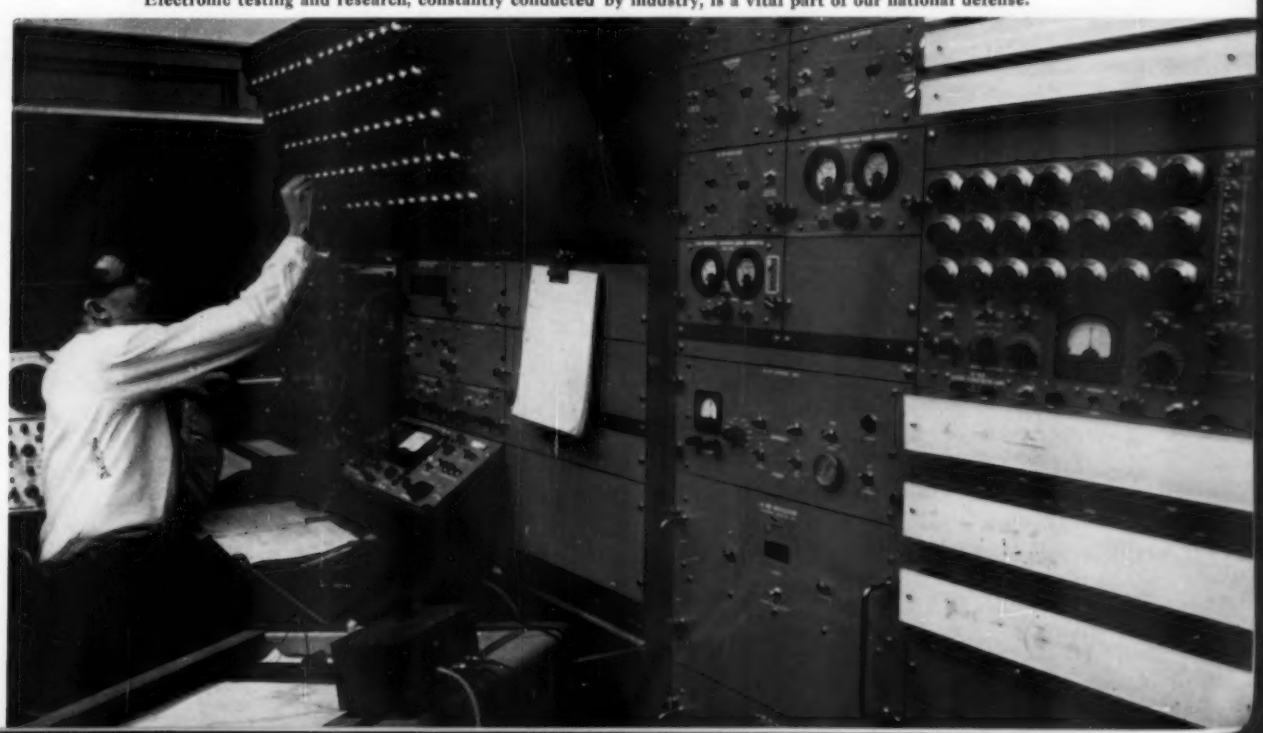
4. Industry must make every effort to keep abreast of the plans of the Department of Defense.

The military must fully realize that it cannot define new requirements and expect industry to produce, overnight, the matériel needed to satisfy those requirements. The military also must realize that it must keep industry informed—as far as is practical in the light of security and need to know—of the influence that policy may have on weapons technology.

5. Industry must plan its own programs—or salable "best bets"—which are based on the consideration mentioned above so as to effect a conservation of our talents and resources.

Under such a program, industry becomes a key for defense, and industry's plans become a study for survival.

Electronic testing and research, constantly conducted by industry, is a vital part of our national defense.



What of Manned Aircraft?

Until adequate space craft are available to perform reconnaissance, fighter-bomber, and transport missions, the manned vehicle will be needed to assure victory in combat as well as our ultimate survival

William V. Kennedy

IT is not the purpose here to discuss the relative merits of a particular type of aircraft. It is intended, rather, to examine the broad requirements for air vehicles as established by the conflict between the United States and the Soviet Union.

A review such as this is essential at this juncture in the military-technological revolution. We cannot afford to retain overly long the tools and the methods of the past. Neither can we afford to discard valuable and essential tools, weapons, and skills merely for the sake of "looking modern."

The manned aircraft has a future, and that future probably will extend throughout the lifetime of any man now on earth. The recent reemphasis placed on modernization of the Military Air Transport Service and the growth of Army Aviation to some 6,000 light aircraft and helicopters, are symptomatic of a great and growing national need.

JUST what the national interest may be is less clear, however, when we approach the field of long-range heavy bombardment.

"Retaliation," a distinguished Marine Corps officer commented to this writer some months ago, "is an emotion, not a rational policy."

If, however, "retaliation" or, more precisely, revenge, is to continue to be dignified as a national policy, our present manned bombers should be scrapped as rapidly as the new Atlas, Titan, and Minuteman squadrons become operational.

Mr. Kennedy has served as an enlisted man in the Regular Army and as an Intelligence Officer in the Strategic Air Command. He is now a free-lance military writer and an officer in the Governor's Troop, 104th Armored Cavalry, Pennsylvania Army National Guard. Mr. Kennedy lives in Camp Hill, Pa.

To say that we are prepared to answer an enemy attack by the virtually unlimited employment of megaton weapons against cities, airfields, hydroelectric plants, and military headquarters is to make words like "precision" and "selection" somewhat silly. Once a hundred or so such weapons have been dispatched, we might as well go on "firing for effect" until our whole arsenal is exhausted.

Missiles, even with their wide margin of error, can do a blanket job such as this much better than the manned bomber—and with less bother from enemy defenses.

There is a question whether those who established "massive retaliation" as a policy ever really subscribed to its implications. The events of the past several years, in which we have gone to all sorts of extremes to avoid any situation in which this policy might be put to the test, would seem to bear out such a conclusion. In addition, we are now faced with a world opinion mobilized against the use, or even the testing of nuclear weapons.

The policy of massive retaliation has long since been modified in fact. It must soon be modified, also, in words.

This, then, opens up an entirely new perspective as regards the future of the manned bomber, a perspective in which the words "precision" and "selection" are of enormous importance.

When man is pitted against man, the bayonet and the hand grenade are adequate weapons. When continent is pitted against continent, nuclear, though not necessarily megaton, weapons have a legitimate place in the military arsenal.

BUT, as we have learned from the experiences of Nagasakai and Hiroshima, the use of even one such weapon is fraught with social and political implications that may be with us for generations.

We are headed toward a situation in which large nuclear weapons can be employed only against targets of overriding military significance, a situation in which close attention and deference must be paid to the attitudes of the world's awakening and increasingly knowledgeable populations.

Through scarcity of weapons and adequate means of delivery rather than out of any special concern for world

opinion, the Soviets arrived at this point in planning long ago.

The translations of Soviet military thought that have become available over the past five years, including those written after the first Sputnik, have made it plain that the Soviets have never banked on indiscriminate nuclear bombardment. Rather, they have relied, and continue to rely, on large nuclear weapons as merely a covering fire for the employment of land forces.

The Soviets do not wish to occupy a desert. We do not wish to become the pariahs of the human race.

THE Soviets can afford to be somewhat more careless in their method of attacking a target. Hence, their vaunted rockets may indeed be adequate to their needs. Whether we attack a target by missile or by bomber, we must be absolutely certain of the results. Only a man with proper photographic equipment, who has been there and seen the damage, or the lack of it, can provide this certainty.

Effective, dependable satellite systems capable of performing reconnaissance of this nature are still a long way off. Since we must, then, send the man and his camera, we should attempt, for as long a time as requirements of speed and weight will permit, to have him deliver the bomb.

The advantages of control and selection provided by the manned bomber have long been recognized as desirable. A question remains as to whether the manned bomber can penetrate modern antiaircraft defenses.

The U-2 flights demonstrated that Soviet defenses could be penetrated at high altitude. They have confirmed, further, that our present manned bombers, employing a combination of mass, electronic countermeasures, and deceptive tactics, can still reach the majority of their targets either directly or by the use of air-to-ground missiles.

To a great extent, the most important lesson of the U-2 flights unfortunately has been ignored: Had we made haste with the production of more advanced manned bombers, our superiority in long-range nuclear bombardment forces would not now be in doubt.

We cannot, at any time, come to depend on a long-range bombardment system that is essentially without human control and observation. Until adequate space craft are available to take over the reconnaissance mission, we must provide manned aircraft capable of observing the precise strike of a missile or their own bombs and of reporting that information promptly.

The manned aircraft has a future in long-range bombardment for the simple reason that it *must* have such a future.

The future of the manned aircraft in the field of tactical aviation is best indicated by the present emphasis placed on "battlefield surveillance."

However useful they may be for short-range observation, the drone and the ground radar can scarcely begin to meet the requirements for thorough, deep reconnaissance of the battle area. Despite its increased vulnerability to ground-to-air missiles, the manned aircraft, jet or conventional, remains the only satisfactory means of accomplishing this vital mission. The problem here is not so much that of technology as of organization.

The ground commander already possesses a twin-engine, relatively high performance aircraft for distant reconnaissance. Should he, in addition, be assigned the jet aircraft needed for long-range reconnaissance? If such is the case we will be seeing not a fading away of the manned aircraft but a virtual rebirth of the old Army Air Corps.

NO matter how well the missile and the drone or reconnaissance aircraft may be coordinated, prompt, effective engagement of targets of opportunity, such as a moving tank column, will continue to demand manned fighter-bomber aircraft. As Lieut. Gen. Arthur G. Trudeau, U. S. Army Chief of Research and Development, observed re-

Artist's conception of the B-70 supersonic strategic jet bomber now under development (Air Force photo).

cently, the team of armor and tactical air power, expanded by the armed and troop-carrying helicopter, is still the decisive element of land power.

The Soviet Union is at least as well aware of this fact as we are. Success on the land battlefield continues to depend, therefore, on the winning and the maintenance of aerial superiority. The fighter-bomber must, then, retain the ability to engage in air-to-air combat. In addition, considering the demands of specialization, the fighter-bomber must be supported by fighter-interceptors, the "top cover" and the final, decisive force in the struggle for control of the air over the battlefield.

SIMILAR fighter-interceptor forces must be retained for the defense of the homeland. No missile yet devised can replace these aircraft in the search and identification phases of air defense, or in the protection of the vast reaches before and between the limits of the missile defenses.

It seems almost inconceivable that the United States, faced with these continuing and imposing requirements for manned combat aircraft, should have slowed down or suspended entirely the development of more advanced fighters and bombers. Yet this is precisely what has happened.

Equally disturbing is the lack of foresight and imagination that appears to afflict our national policy in regard to military transport aviation.

Whether the combat phase of a total nuclear war lasts for three days or for three thousand days, the need for transport aviation will grow almost beyond present comprehension. Yet we have limited our stated requirements for air transport to the strictly military support aspects of the conflict—and only to the opening phase of the conflict at that.

If even one major nuclear weapon were to be delivered on an American city, the fallacy of this planning would become immediately apparent. Delivery of the dozen or so weapons required to accomplish stated Soviet objectives would bankrupt our transport aviation resources completely. This without even considering the necessity for flying reenforcements to overseas theaters.

It would seem obvious by now that no single metropolitan area or State could handle the casualties from a nuclear attack on the heart of a major city. The country as a whole must carry the burden. Surface transportation will be in a state of chaos. The only hope for treatment lies in rapid aerial evacuation to hospitals hundreds and even a thousand or more miles from the scene of the disaster.

The Civil Reserve Air Fleet, consisting of commercial air transports and crews, could not be converted to an aeromedical evacuation role quickly enough to be of major importance. Almost the entire job would fall to existing military aeromedical and general transport units.

Between the active Air Force and the Air National Guard there are now available in the entire United States less than seventy-five "air evac" aircraft with trained crews, including medical personnel. Fantastic though it seems, an attempt is currently being made to deactivate the active Air Force portion of this tiny, but invaluable force.

Here, then, in only one small portion of the over-all transport situation we can see a requirement for vastly increased resources in terms of both aircraft and trained personnel. When we turn to anticipated requirements for cargo lift into devastated areas and for troop deployment, the need for increased air transport is nearly staggering. Certainly it swamps the concept of employing military transport aircraft solely in support of the air combat mission.

Increased budget allocations are part of the answer. The greater part lies in finding new, possibly unconventional methods of expanding our air transport fleet.

A possible "unconventional" answer is to be found at the new intercontinental missile installations. Each of the Snark, Atlas, Titan, and Minuteman installations will possess a substantial number of pilots and other air crewmen who have been displaced into the missile field by the deactivation of manned fighter and bomber squadrons. This "excess" of air crew personnel will continue even if advanced manned bomber and fighter programs are accelerated. Beyond the moment when the missiles are dispatched, these men will have no useful function left to perform.

Could not an air transport squadron be established at each of the new ICBM complexes—a sort of Air Force Reserve in reverse? The squadrons could be manned, in small part, by operations and maintenance personnel assigned to such duties full-time, but mainly by air crews assigned to the missile units, flying on a part-time basis.

The future of the manned aircraft in the bombardment and air-defense fields is, then, tied in closely with our national objectives. We can abandon the manned bomber, fighter, and fighter-bomber only if we are willing to abandon all objectives except simple survival and purposeless revenge. The time we have lost in the development and production of more advanced bomber and fighter aircraft is gone for good, but it is not yet decisive.

In the field of military transport aviation we have passed the time when airlift was an adjunct to the other means of transport. Air transport is now a *sine qua non* of national survival, recovery, and of the final counterattack. The old presumptions and the old theories, based on the concept of "massive retaliation," are no longer adequate.

It is not enough to say that the future of manned flight is in the stars. Few, if any of us, will see the day when manned space flight, in any but a crude and expensive experimental form, becomes a reality. We must hasten that day. But we must also be mindful of the years and decades of sweat and tears that must precede it.

"Whether we attack a target by missile or by bomber, we must be absolutely certain of the results. Only a man with proper photographic equipment, who has been there and seen the damage, or the lack of it, can provide this certainty."

Weapons Readiness Now

The A.O.A. is striving to foster instant preparedness for defense

J. E. Trainer

President, American Ordnance Association

IN the defense of our country history has proved over and over again that high among the greatest problems is weapons readiness—weapons of the latest design, in adequate quantities, when and where needed by our fighting men. I reemphasize: instant weapons readiness is essential to our national survival.

The history books are replete with the tragic record of lack of preparedness. The costs we have paid as a nation are reckoned in the hundreds of thousands of lives of our men, the waste of our material resources, and the squandering of our money—all in frantic last-minute efforts to design and produce the weapons we need to assure victory. Each time we have gotten through by the skin of our teeth—but at a cost that staggers the imagination.

The American Ordnance Association was formed forty-two years ago by a group of farsighted industrial and military leaders. Through duty or close contact with the military services in war, they saw at first hand the crying need for keeping science and industry on the one hand—and the military on the other—in close contact. Each must know the needs and the capabilities of the other, and each must share in the job of weapons readiness.

We have learned too often, and at too great a price, what eleventh-hour weapons preparedness means to our national safety.

Our Association is the only membership society in the country which is devoted exclusively to weapons—all weapons of all services—Army, Navy, Marines, and Air Force.

We are a technical society, not a trade association. We are not concerned in the slightest with procurement. Who makes what is not our business. We are not at all involved in roles and missions of the services—these are the responsibility of the military and not ourselves.

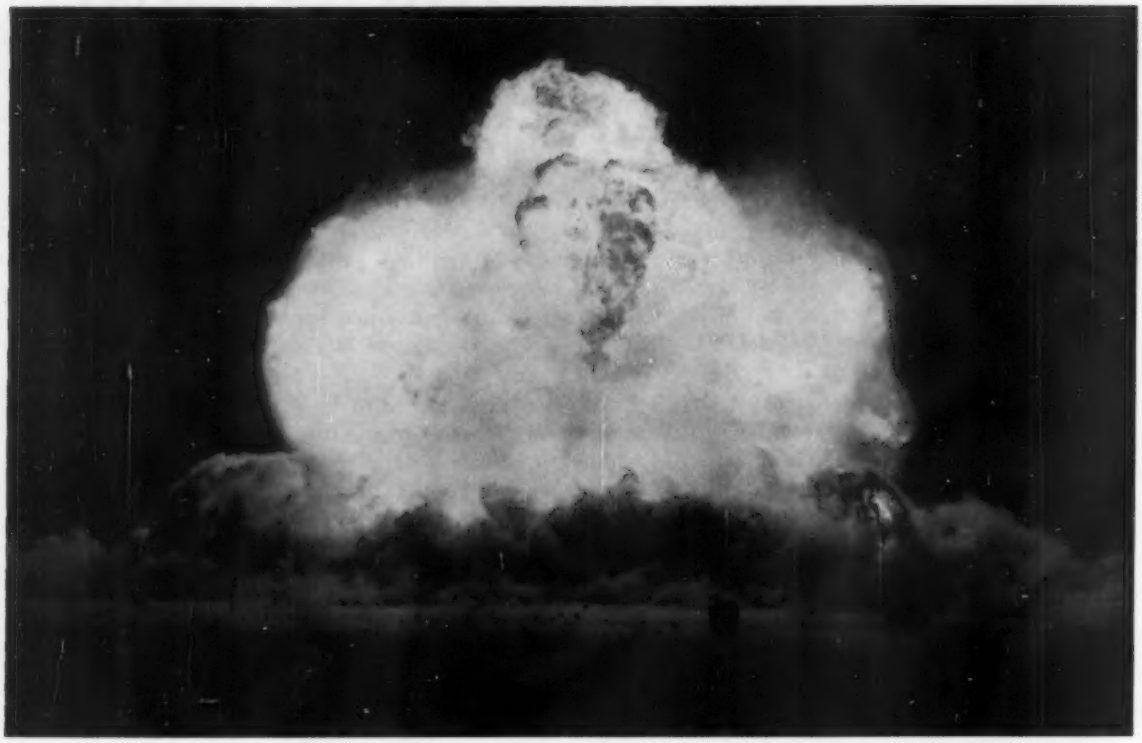
We are not concerned with procurement regulations. We do not lobby. We do not meddle. Neither do we volunteer to tell the other fellow how to run his business. We exist solely to help.

To this end, we offer the talents of our eighty-eight Technical Divisions and Sections for efficient and voluntary assistance in the weapons and weapons-systems fields. We offer the talents of the members of our fifty-four Local Posts and Chapters, from coast to coast, for the enlightenment of our fellow citizens on armament problems and progress. We offer our publications—four in all—in the pages of which we try to make available unclassified information for the education of our members.

WE claim, with some pride, that we are a unique peace society in the best meaning of that term. We hold strongly to the philosophy of the Founding Fathers of our country: that peace is best assured through strength. For us, ordnance readiness is a major factor in that strength.

Our one purpose in everything we do is to help and not to hinder, to facilitate our weapons readiness in an effort to help keep America's armament adequate in quality and in quantity. And, at the same time, we try to help the armed forces reduce costs and stretch the defense dollar, since it is essential that our country have more defense at lower cost.

Trial by Fire



A 30,000-pound shot of TNT, above, is loosed in the desert at the Air Force Flight Test Center, Edwards AFB, Calif., in a joint Army-Navy-Air Force program to test the effect of blast on aircraft which are simulated by the high-speed rocket sled, below, used to carry airfoils through the turbulent area produced by the explosion of various-sized charges.

International Shooting

The United States has the marksmen and the ability to supply the very accurate guns and ammunition for this type of free-weapon competition, but how long is it going to take us to "get with it"?

Col. Robin G. Montgomery

THE "care and feeding" of international shooters constitutes a challenge equaled only by the training and equipping of a sonar operator for the DEW Line. As a moderately recent addition to the American shooting diet, international marksmanship can easily produce gastric disturbances comparable with today's highly spiced domestic shooting menu.

Slick-sheet publications, available to any shooter with minimal assimilation ability, devote chapters galore to Camp Perry, Vandalia, and a galaxy of lesser domestic competitions, but data on international shooting, however, are available only to the true believer who is contaminated by the germ of ultra-perfectionism and is prepared to glean whatever shooting information is available.

International shooting targets are just budding in the garden of bull's-eyes previously monopolized by various species of the "between-the-oceans" variety of domestic targets. Rules, equipment, targets, and facilities inherent to international shooting are currently enjoying a pregnant condition which promises to please the parent when the offspring is delivered.

In identifying problems inherent to international shooting one must decide which arc of the circle shall serve as the base. We Americans enjoy oversimplification and often substitute intention for attention; hence the basic problems must be separated before conquering. To compete with our European and Latin American associates we must readjust certain aspects of our training, weaponry, and ancillary equipment as well as our customary procedures and practices.

Colonel Montgomery is now serving as commander, U. S. Army Advanced Marksmanship Unit, Fort Benning, Ga.

Range distances and, of course, types of targets constitute other modifications which will become necessary prior to our successful entry on the international stage.

From a standpoint of weaponry, the United States is in a moderately well advanced position in spite of the fact that many American shooters contend European-fabricated weapons far outperform domestic rifles and pistols. While some weapons of U. S. manufacture are below European par, in general the recent impetus placed on international shooting has motivated U. S. arms manufacturers to "get with it."

With untold hours of effort directed toward the international shooting horizon, the U. S. Army Advanced Marksmanship Unit (USAAMU) at Fort Benning, Ga., has been attacking the problem of personnel acquisition, weaponry, ranges, and training.

Assigned the mission by the Commanding General of the U. S. Continental Army Command, the USAAMU has proceeded to locate and commence training Army marksmen with potentiality for international shooting. The R.O.T.C. program, currently subjected to divergent opinions, actually produces the finest platform from which the United States can build international free-rifle shooters. These young men, and their varsity or military-science shooting teams, have produced the bulk of competitors now trying to master the intricacies of the International Shooting Union (ISU) challenge.

FIRST Lieut. Daniel B. Puckel, who holds several world's records, along with Capt. Thomas W. W. Atwood, former N.R.A. high-power rifle champion, represent the type of R.O.T.C. graduates now applying their college-stimulated skill in the international shooting arena.

There are many other young men of equal posture who gained their basic experience in service academies or in high school, and this coterie of American manhood represents the hope of the United States in dislodging the Soviets from their predominant position as the shooting champions of the world.

The Army Advanced Marksmanship Unit is not the only service organization attempting to shore up our beginners' efforts in the ISU realm, but to date the only complete set of rifle, pis-

tol, running deer, and shotgun ranges on which international teams can be trained is located at Fort Benning.

No credit is meant to be subtracted from the U. S. Air Force, with their Valhalla of shooters at Lackland Air Force Base, nor the energetic U. S. Marine Corps marksmen at Quantico and Camp Pendleton. These two services have no intention of allowing the U. S. Army to capture or maintain the dominant role of representing America in the international field without contest.

Commanders with foresight have seen the crying need for America to emerge from the conventional shooting cocoon, hence the services are mingling international shooting with the military mission of marksmanship-training proficiency.

The metamorphic result is not only a better shooter but a more self-disciplined serviceman. Patience and attention to detail are hallmarks of the international rifle and pistol shooter. By instilling these qualities in our military shooter, we are improving his over-all military posture and thereby increasing his leadership potentialities.

By emphasizing international shooting, no diminution of the service-weapon shooter is intended. These marksmen use their prowess as competitors to impress their troops and students with the validity of training techniques. It is easily understood why large portions of domestic shooters are alumni or protégés of the military services.

The civilian marksman population at Camp Perry vividly attests to the American interest in competency in marksmanship, hence with this wealth of accomplished and devoted marksman there is little excuse for not developing international shooters who can maintain U. S. prestige on worldwide shooting ranges.

HIGH-ORDER competitors like Capt. William McMillan and Sergeant Hill of the Marine Corps gave adequate testimony in the 1960 Olympic Games that America has the potential to dominate the international shooting sandlots if we "get with it." Training and weapons are becoming sufficiently effective to place us among the world record holders only if we marry the people to the inanimate objects they have the potential to master.

It is interesting to note that the Soviets have published a complete book of several hundred pages devoted to the art of shooting, ranging from muscle tonus to ammunition loads and psychological impacts. Admittedly this tome smacks of socialized publication, but the efforts of their marksmen, psychologists, anatomists, and ballistic experts have given a target for the West to shoot at. Allowing their people to compete in marksmanship as a subsidized hobby cannot be scoffed at by any marksman.

We in the United States have a penchant to deride control, but control and discipline are occasionally bedmates. The inherent capabilities of an indigenous population are favored only through application, and, with continued attention rather than intention, it is quite probable that American shooters will rise to the top.

Training facilities, coupled with devotion to purpose, and good ordnance to support the competitor, are rapidly being recognized as the minimum essentials for success. Without any singular guidance in the form of a monolithic manual, there is a great possibility that trial and error among the international-type shooters will eventually produce top performers for any country.

The USAAMU is attempting to weed out disproved theories and impractical methods in the hope of developing a training program which will be palatable to, as well as productive of, champions. Hope actually rests with the marriage of our skills and potentials with the individual's desire and wherewithal.

Several examples of success in the international shooting arena clearly indicate we are on the right track. The World Championships at Moscow in 1958 concluded with several Americans winning their events. These winners were not appointed to the U. S. Team by virtue of their fraternal affiliations but because they were superior shots and second-to-none competitors. Captain McMillan, U.S.M.C.; Lieut. Joe Deckert, U. S. Army; Lieut. Verle Wright, U. S. Army; and Lieutenant Colonel Eisenlover, U.S.A.F., were all gold-medal winners. Lieutenants Puckel and Lucker of the Army as well as SFC Lincoln also placed in the championships.

By utilizing the skills of shooters and adding a mixture of better equipment, as well as improved ammunition and successful training programs, we are now approaching a plateau where more competitors are becoming available to shoot their way onto the American team, rather than being appointed. Of the 1958 winners and the 1960 Olympic Game competitors, very little need be said of the American's ability. However, a new crop of international marksmen is our main concern. We cannot lean on past winners to carry our burden forever, and each year one or two younger or new shooters is tossing his hat in the ring.

IN so far as personnel are concerned, one critical shortcoming can be remedied only by time—the acquiring of American coaches for international shooters. Successful shooters are reluctant to hang up their spikes or sights and start coaching, and a shooting coach *must* have a successful past as a shooter in order to impose his leadership authoritatively. Breed coaches and we will beget shooters; wait for coaches from the ranks of retired shooters and wait indefinitely.

Rather than belabor theory, hope, or speculation with reference to building up our international shooter fraternity, it may be wise to recognize the problem before attempting to resolve it. The most important ingredient of any activity is man (or woman). Although many international rifle competitors enter the field with gallery (small-bore) experience, a problem arises when entries for free-rifle competition must be assembled.

The butthook, palm rest, and feather trigger set the international rifleman apart from his domestic rifle cousin; hence, the transition from the M1 rifle squad to the free-rifle squad is a major undertaking.

A greater problem exists however,

when we attempt to convert a domestic pistol shooter into a free-pistol exponent. Courses of fire in the rifle portion of international shooting do not precipitate the ulcerous condition that the free and rapid-fire pistol generate—but only because there are more riflemen.

Personnel in any phase of international shooting must steel themselves to learn new shooting habits. The rifle and pistol shooters must undertake a new way of life. Shooters therefore are subjected to training courses and practice firing, pivoted around a "relearning" program. Many old and successful accomplishments in domestic shooting must be unlearned, while at the same time the cardinal facets that made them good in the first place must be remolded to fit the new challenge and the routine.

Foreign countries have a source of "old shooters" to serve as coaches; not so in America. The embryonic stage of international shooting has not been effective long enough to provide a society of elder statesmen who have proved their capabilities as shooters. The shooter wants to be certain the man telling him what to do has done it before, successfully.

Personnel for the international shooting clique must be exposed to sufficient training competitions to maintain proficiency. To date, no sizable match, employing the full arsenal of international-type weaponry, has yet been conducted.

The armed forces are attempting to bolster this lack of competition through interservice rivalry which commenced in 1959 when positions for the U. S. Team of the Pan American Games represented the objective for All-American shooters.

Too few people shooting for too many slots does not produce optimum competition, in spite of the good intentions of those participating. We can "get with it" as soon as we enlarge the personnel base of international rifle, pistol, and shotgun shooters.

ALONG with the personnel problem is that of weaponry and ammunition. For many years Europeans have not only dominated the field of competition, but weaponry as well. This condition must be regarded as natural since competitive shooting had its origin in Europe. Weaponry and ammunition for competitive purposes were designed and manufactured to support the type of shooting the various countries were undertaking. Periodically an American "shooting bug" would acquire some of the European's sophisticated weaponry and commence a handload operation in his cellar to support his new-found love logistically.

During the past five years American industry has stepped into the act and relieved this struggling individual. Several of our large arms and ammunition firms have cut into their gross proceeds in order to support this embryonic effort.

Likewise, the U.S. arms industry is conducting research in ammunition to support the complicated weaponry which demands perfectionism in ammunition. Fitting an international shooter to his weapon is an operation rivaling orthodontia. The self-discipline generated by an international shooter is such that he can make no error; all errors must be of inanimate origin.

The only valid solution is to supply the shooter with arms and ammunition of unbelievable accuracy. This function is rapidly taking place in America, thanks to some of the more perceptive men in the industry. Their assistance to the shooter closely rivals that of his coach.

Of all the problems we must attack

World's free rifle champion, Lieut. Daniel B. Puckel, U.S.A., sights in on practice range (Army photo).

and eliminate, the acquisition of qualified and devoted marksmen remains paramount. From all outward appearances the armed forces will continue furnishing the much-needed support to crystallize our international shooting successes.

This by no means should be interpreted to exclude the American civilian population which constitutes the world's finest pool of potential shooters who eventually will establish competitive organizations to challenge the military supremacy. All that is needed is leadership, which incidentally is presently being enthusiastically generated within the N.R.A.

ASSUMING, therefore, that the personnel problem is in the process of being remedied, it is only prudent to examine other facets of the shooting question which must be considered in America's ascendency to international championships.

Additional support must continue to be forthcoming from that already overburdened segment of society—industry. Whenever we Americans are confronted with any sort of challenge, the moniker, "Industry," becomes the mystic talisman. To extol the virtues and accomplishments of American industry here would be the height of redundancy. What is needed however is a full recognition of what is necessary of the manufacturing fraternity before they should be expected to answer the call.

Any shooter has the inherent right to visualize an "ultimate weapon" with characteristics capable of making his hits all "X". To ask industry, however, to solidify the visions of every shooter is undoubtedly impossible. Fools can ask more questions than wise men can answer, and it is unrealistic to imagine that international shooting weapons can slide off the drawing board with the speed with which shooters can envision them.

However, within the framework of the American arms industry, there will have to be products available for the international shooter—available both as to cost and competency. The composition of an international weapon is a symphony that does not just happen. To place an accurate, well-balanced, foolproof weapon on the commercial market is a task not easily accomplished.

However, to give our personnel the same chance of success as that available to our competitors, somewhere in our arsenal of industry we must develop the guarantee which will provide him the tools of the trade competent in quality as well as quantity.

The successful and tranquil marriage of arms and ammunition has long been one of the prime goals of our weapons industry. Within the sphere of military weapons, rifle and pistol, immense strides have been accomplished in the supply of the precise type of ammunition for any given mission.

In the field of international shooting this accomplishment will have to be improved upon continually, not only because we are starting a bit late in the game, but because we undoubtedly will have an array of small arms in which each group of rifles or pistols of the same type will require particular ammunition affinity.

For years we have known that one type of ammunition will function better than a counterpart in a particular weapon under identical conditions; conversely, the chosen ammunition in one case is rejected for the same weapon under closely related conditions.

The predominant ammunition in the realm of international shooting is caliber .22. Both rifle and pistol competitions are predominantly of the small caliber. Not only must we discipline our shooters to the art of this small-bore shooting; we must inject an additional science into the marriage of ammunition to the weapon. This feat is neither mysterious nor insurmountable, but merely exacting and painstaking.

In the past three years the major ammunition manufacturers have reduced the maximum vertical spread of caliber .22 ammunition nearly forty per cent. Ammunition accuracies have an ambrosian effect upon any shooter; he learns rapidly that one other excuse for lack of proficiency has been eradicated and an additional burden is being placed upon him to "get with it." He needs perfectionist's instruments, and when so provided there is little doubt of his success.

THE element of training is presenting one major obstacle as an interim barrier. As mentioned, coaches are practically nonexistent. Add to this condition the strangeness of the targets, the units of measures, times, procedures, and the inability to generate competitions within America, comparable to those in Europe.

The metric system poses no unresolvable problem. The 50-meter target plus the large black ring of the 300-meter target (with the extremely small "X" ring) is less consoling. Gone are the days of the "possibles," so prominent these past few years at Perry.

The international rifleman is being forced to satisfy himself with approximately 95 per cent of hits in the 10 ring. He is shooting prone, kneeling, and standing—substituting the less stable kneeling position for our domestic sitting position. There is no rapid-fire event in the rifle phase, but there is an extended-period time of hours to fire the 120-round course.

All these features make for adjustment, not in the direction of ease, but toward complication. The free-pistol shooter must be prepared to devote hours to complete his course of fire where he devotes minutes in our domestic tournaments. The rapid-fire pistol shooter must undergo a transition from the familiar bull's-eye target to a slim and lean silhouette.

Not being satisfied with the alteration of our current menu, another dish, the running deer or roebuck, is entered as a portion of the international shooting diet. Last but not least is the difference between international trap and skeet and the American shotgun events.

Intimately describing each segment of the rapidly rising international shooting wave must be witheld for the volumes of training literature which will inevitably follow. The general acceptance of improved weaponry, ammunition, and training, as well as the awakening of Americans to this change of pace, is only a matter of time.

We Need Civil Defense

The lack of passive protection for our civilian population will make the United States an inviting target for enemy nuclear bombs in the event a future conflict should degenerate into an all-out war

Anthony G. Priest

Mr. Priest is a civil and structural engineer, now living in Flushing, N. Y. At the close of World War II, he was employed by the Allied Control Commission to supervise the conversion or destruction of the large public air raid shelters in Germany.

EVER since mankind started to use force as a means of settling differences, offensive weapons have competed with defensive weapons for superiority, and every time a new offensive weapon was devised, there followed a rapid development of defensive devices and methods to counteract that weapon.

It is interesting to note in this connection that, while in the history of war no weapon for which no countermeasures could be found has been designed, some forces in this country, and surprisingly only in this country, have succeeded in spreading the widely accepted thesis that there exists no defense against a surprise attack of atomic weapons besides instant retaliation.

The result of this fantastic and baseless propaganda is that the civilian population as well as industry and transportation in this country are hopelessly exposed and defenseless. There are various estimates of how many millions of Americans would die before retaliation could start.

NOT so much publicity is given to other studies that have been conducted by other competent and able agencies, which estimate that sixty to ninety-five per cent of the population affected could survive an atomic attack if suitable shelters were provided.

We must not deceive ourselves that a future war will be fought only between the armed forces of inimical countries. Since the notion of "total war" has been invented, the target is the weakest point of the enemy, and the will of resistance of a nation must be broken first and as quickly as possible.

The lack of elementary protection of the civilian population of the United States makes it very attractive and inviting to inflict the first massive blow on the civilians and to give them the convincing impression that the only feasible choice is unconditional surrender.

It must be noted here that it is not the author's claim that an atomic attack would result in no casualties. Such a feat cannot be achieved short of putting the entire United States underground. It must nevertheless be realized that a Third World War can only be won by the side that can emerge from the holocaust of the first attack and still carry on with at least the fundamental task of maintaining the basic functions of life, along with carrying on the production and the industry so necessary for the armed forces.

Shelter design and construction is basically a civil-engineering task. If there were no suitable shelter types for the protection of the civilian population, the civil engineering profession could be accused of failing to live up to its duties. Indeed, the alleged hopelessness of any defense or protection is a silent accusation against civil engineering and construction, perhaps mingled with some pity that they are confronted with problems which go way above their heads and beyond their capabilities.

IN face of this accusation—which could be raised at any moment—it should be emphasized that *shelter design and construction is technically a solved problem*. Any degree of protection can be achieved, and the shelter construction program could start tomorrow as far as the civil engineers and contractors are concerned.

The big lie to the claim that no defense exists against atomic attack is given by none less than the engineers of our own Army and Navy who, from the very beginning of the Atomic Age have quietly and industriously collected data and made experiments that could serve as a basis for protective measures.

The results of these studies have been published and are available. "The Effects of Atomic Weapons," and the

latest edition, "The Effects of Nuclear Weapons" (1957), sponsored and published jointly by the Department of Defense and the Atomic Energy Commission, are basic references in this field. These books discuss only the principles of protection; the implementation of the principles is left up to other Federal and State agencies. These agencies, however, are badly neglected by Congress and receive only nominal appropriations.

Practical details of shelter construction also have been developed by both civilian and Army-Navy engineers. These studies show that practically any degree of protection could be achieved and would depend on one factor only, that of cost. The practical possibility of shelter construction has been proved and details are freely available, yet hardly any shelter building can be found in this country.

It is a tragic irony that more shelters have been constructed abroad—very possibly in Soviet Russia, too—based on the studies named above, than in this country where those same studies have been made.

Naturally, many technical problems and details still must be solved. Although standard types of shelters could be worked out, the skillful adaptation of the principles to local conditions will always require civil engineers well trained in civil-defense principles.

Coordination of communication and transportation requirements, from the point of view of emergency functions, will need the cooperation of many engineering branches, and the technical problems of implementation cannot be underestimated.

THE technical difficulties of civil defense, and especially of shelter construction are, however, negligible as compared with the problem of the complete legal and public-relations vacuum around civil defense. Shelter construction must always be mentioned since shelters are the focal points of passive defense. Civil defense without shelters is like a navy without men-of-war or an air force without airplanes. Without shelters the sirens, the distribution of radiation detectors, and even the whole civil-defense organization make no sense at all.

The Civil Defense organization—which otherwise worked excellently and very efficiently after the tornado in St. Louis on February 20, 1959—was seriously hampered during the first hours after the storm because the tornado *damaged the Civil Defense headquarters which was not located in a shelter!*

People must know where to go when the sirens sound the "red alert" and they must be confident that the sign "Shelter" means at least some reasonable protection, not only a place among glass windows and panels where the broken glass projectiles resulting from a blast could kill many of them. The panic-averting value of shelters is alone worth the cost. Some military experts know that modern war cannot be conducted for even two days without suitable protection of the civilian population.

We must not forget that the party which wants to strike the first blow can protect itself much better against any retaliation. It may have weeks for preparing its industry to take cover and precious hours, if not days, for warning and evacuation of civilians from the most exposed areas. This advantage alone could reduce the effectiveness of retaliation by a considerable proportion.

The argument most often used against shelter construction is the cost. No doubt shelters will cost large amounts of money, and it is argued that this is wasted money.

It is very difficult to say what is wasted money in military expenses. Until the Russians launched the first Sputnik, most people considered money spent for rockets wasted. Nowadays, if a missile, costing around $3.5 million, explodes shortly after taking off from the launching pad, this is considered—perhaps quite correctly—as a necessary step toward development. That from this amount of money permanent and substantial shelters could be constructed for about 20,000 people is beside the point.

Almost every type of missile has its promoter—some of them even have a lobby—in the laudable effort to save the country with the best possible offensive weapon. Unfortunately, 170 millions of American civilians have no lobby and no representation for adequate shelter and protection.

One of the most important aims of civil defense should be the encouragement and promotion of the building of more fire-resistant private and public buildings. Mr. Prentiss, writes in his book, "Civil Defense in Modern War," that about eighty per cent of the total number of houses destroyed in Germany during World War II were destroyed by fire. Considering the much lighter weight of incendiary bombs, these were 4.8 times more efficient in destruction on an equal-weight basis than explosive bombs.

The extremely intense heat radiation of nuclear weapons has increased the fire hazard of inhabited areas immensely, especially where most of the houses are built with highly inflammable building material. Future homes should be built with the maximum possible elimination of all easily combustible materials.

THIS is not only a civil-defense precaution; the additional safety is highly welcomed in peacetime as well. Fire damaged or destroyed an estimated $1,056 million worth of property in the United States in 1958. More than 300,000 homes were destroyed by fire during one year. A publication of the National Board of Fire Underwriters states that every 37 seconds a fire breaks out in some city in the United States—there were 865,561 reported fires in communities of 2,500 or more during 1956.

The requirements of fire resistance in residential buildings must be tightened and considerably increased in the building codes. Many European building codes specify that between basement and main floor a fireproof slab or floor construction must be established. Some building codes require that in multistory buildings a fireproof ceiling must be built between the uppermost floor and the attic.

These requirements have saved many a residential building from fire, especially in the territory of the former

Austro-Hungarian Monarchy, where the building regulations were generally more conservative than even in Germany. Our National Building Code requires only one hour fire resistance rating from wall and ceiling construction around boiler and furnace rooms (Section 1101).

This writer has recently renewed his fire and theft insurance policy. The insurance was amended by a rider, which said, among other things:"(1) The following exclusion is added: (f.) to loss due to nuclear reaction, nuclear radiation, or radioactive contamination, or to any act or condition incident to any of the foregoing."

This means that we are facing any nuclear attack at our own, personal risk. The logical conclusion would be that we citizens must protect ourselves as best we can because nobody else cares about our passive protection.

The cold war began at least eight years ago. Since then, more than 9 million houses have been built in this country. It would be a fantastic advantage if the building codes had been revised eight years ago and all new houses had a more fire-resistant structure. It may sound outlandish today, but the new building code should also require the establishment of underground shelters for the whole occupancy of all new buildings.

As soon as the establishment of shelters is made mandatory, a whole array of fiscal and legal questions will arise. Unfortunately, our legislature is not at all prepared to deal with this type of problem, to say nothing about a solution. The Senators and Representatives have a priority list of topics which interest the voters, and on this list civil defense has a rather low priority. In this case the voters look to their elected representatives for guidance—in vain.

WHILE the Government points out at every opportunity that no one should expect any Federal action in shelter construction, because this is a private responsibility, the Federal Government itself penalizes any private initiative in this field by increased taxation. It should be obvious that shelter construction must be promoted by tax exemption at least, if the Government is not willing to promote the passive defense of its people otherwise.

Nobody outside this country, and especially none of our NATO allies, will understand that in the United States grain silo construction costs can be written off in five years, while shelter construction is penalized by increasing the assessment of the house.

The American Government pays $14.7 million annually to one man alone for the storage of surplus grain, and "the Senate Appropriations Committee flatly turned down Civil Defense Chief Leo Hoegh's modest request for $13.15 million to get a prototype shelter program started" (*Time*, August 25, 1958, p. 11).

It is not our fault that we must deal with this problem. H. S. Dinerstein states in his book, "War and the Soviet Union" (Praeger), that while Malenkov believed that an atomic war would destroy all civilization on the earth, Khrushchev and his entourage strangely came to the conclusion that a nuclear war would destroy only capitalism and that Communism would escape unscathed, for large units of key Russian industries are not only dispersed but are also actually underground.

The indifference of the United States toward the passive protection of its population seems to support Khrushchev's assumption.

The only possible way to survive the casualties of another Hiroshima is use of especially built shelters.

Survival with Victory

American industry must plan to withstand a surprise attack and to wage "broken-backed warfare" by dispersal of plants and materials, building of underground factories, and use of an Industrial Reserve

Col. Virgil Ney

IT is too late to speculate upon the improbability of a nuclear attack upon the United States at the hands of the Soviet Union. In fact, the current spokesman for the Soviet political hierarchy, Nikita Khrushchev, has threatened the United States with the intercontinental missiles now at his disposal. This ill-tempered "missile-rattling" has not frightened the American people; in truth, it has had the opposite effect.

In view of its source, this threat must not be taken too lightly, as it must be remembered that it comes from a man who is godless and without any sense of absolute value. Further, as a Communist he is dedicated to historical, dialectical materialism which considers men to be material to be used as the state desires. In addition, he is consecrated to the ideology of world revolution. Such a man, in a moment of temper-triggered decision, could push the button.

FORTUNATELY for the United States and the nations of the free world there are several important deterrent forces which inhibit Chairman Khrushchev from taking such fatal digital action. Among the best known of these factors are: The United States Strategic Air Command; the United States ground and sea forces; the United Nations; and NATO.

Other deterrents of more passive nature are Khrushchev's own fear of what retaliation will do to obliterate the industrial and population centers of the Soviet Union and his prospective antagonist's ability to wage "broken-backed warfare" after receipt of a preemptive attack.

Colonel Ney is an expert in the fields of guerrilla warfare and propaganda. At present he teaches American history at George Washington University, Washington, D. C.

The ability of a nation to wage "broken-backed warfare" depends upon several factors; namely, the readiness of industry to function in event of an attack and the ability of the surviving population to continue to operate the machines and produce missiles and the required components. American industry must continue to prepare to wage this unknown and untried kind of warfare, for in our possession, before the world, of such capability may be found another powerful deterrent to hostile attack.

Aside from the destruction of population, industrial complexes, and stockpiles of critically needed supplies, including food and clothing, the first nuclear blasts would cause other problems, most difficult of solution *without prior planning.*

The simultaneous receipt of intercontinental missiles in several geographical areas of the United States would have the effect of setting up a compartmentalized national economy. Primarily this situation would follow the piecemeal destruction of the rail transportation net and the irreparable damage to highways and strategic bridges.

The total effect of this condition upon industry's ability to continue operations would be the denial of critical materials because of lack of transport. This is a serious factor in a most complicated problem—the solution to which may be found, at least partially, in adequate preattack preparation by the Nation's industries. A suggested plan for the phasing of industrial preparation for "broken-backed warfare" is included in the schedule on page 795. It should be noted that the "phasings" and periods coincide with the current Civil Defense survival planning format. The "activities" are the author's suggestion, and the responsibility for their locations and sequences is his.

PHYSICAL dispersal of present-day industrial plants, complexes, and stockpiles of raw and processed materials must continue to be accomplished on a time schedule agreed upon by management and the Government. Management's attitude must take as its basic position that the preservation of its ability to survive and function after a nuclear attack will depend upon planning and preparation during the preattack period.

The "removal of all the eggs from

one basket" type of concern for the survival of personnel, plant facilities, and machinery is the motivating factor behind such *voluntary,* forward-looking, and wise action by industry at all levels.

The first step to be taken by management in order to put its house in order to meet and resist enemy attack upon this Nation is for the superintendent of each factory under defense item production to continue to study and recommend and accomplish dispersal and decentralization procedures in consonance with the industrial planning contained within the National Survival Plan of OCDM and Defense and other local and national governmental agencies.

The fabrication processes, where possible, should be broken down to branch factories in regional areas of the country near raw materials and excellent transportation nets. Available labor in the area may furnish much of the unskilled and semiskilled personnel; the skilled labor needed may have to be brought in. The frequently mentioned mobility of American labor may have to be tested severely in order to effect this transition from stability to mobility.

BRANCHES thus established can further effect the dispersal pattern by setting up subbranches especially for the manufacturing of smaller components. Where subbranches are not feasible, subcontracts to widely dispersed manufacturers will accomplish the component breakdown desired.

Stockpiling of raw and semifinished materials will continue to go *underground* and *underwater.* Underground stockpile caches of necessity always will require alternate types of available transport. The possibilities offered for protection of certain types of materials from attack by storing them in underwater warehouses make these installations very appealing to imaginative management. Submarine freighters, when not on their runs, could fit into this category with ease. This is especially so with regard to nonbulky highly critical items—chemicals, precious metals, etc.

In order to effect acceleration of the dispersal program envisioned herein, the Federal Government, with the proper legislative authority—*i.e.,* the National Defense Act, as amended—should be prepared to grant industry the necessary funds where required. The ultimate benefactors of such action on the part of the Government would be the people themselves in their ability to survive when and if nuclear missiles were ranged in on the United States.

It appears to the author that industry, itself—would receive a tremendous accelerator effect in the resultant new plant facilities, expanded business operations (in time of peace), and additional strength through acquisition of a new and diversified labor force. The total effect of the continuation of the dispersal program of American industry, under a system of free enterprise assisted by Government loans and grants, is difficult to measure.

In depressed areas where employment is seasonal or generally low because of the usual economic factors, activities generated by the dispersal program might effect an incalculable economic revival. For example: a mining region which was no longer productive in coal or mineral ores could be adapted and converted to the dispersal effort by furnishing ready-made locations for underground factories or stockpile caches in the abandoned mine shafts and galleries. Another most important factor is the availability of transportation, at the mine or pithead, for heavy and bulky freight.

IN pursuance of a dispersal policy in the construction and location of new installations, industry must ensure that the new construction has some degree of resistance to nuclear attack, either materially or positionwise in relation to the terrain. The following criteria should be met in the siting of any factory to be constructed now or in the future:

1. It must be located away from population centers.

2. It must take advantage of the protective features of the local terrain. Mountains and valleys are preferred to open country.

3. It must be constructed of materials as nearly nuclear-attack-resistant as possible, and it must provide safe underground shelters for the labor force (maximum, plus one-half).

4. It must be located if feasible near a source of raw materials and adjacent to rail and highway networks. Electric power and water must be available—with plans to include the building of a factory power source.

5. It must be able to find available labor forces in the area—or the area must be capable of providing dispersed housing for employees at convenient distances.

Industrial phases in preparation for "broken-backed warfare."

Phase	*Period*	*Activities*
1	Preattack	Preparation, planning, training, shelter, dispersal, stockpiling, testing, and rehearsal.
2	Warning	Evacuation and shelter, dispersal, protection of equipment and machines.
3	Attack	Survive, maintain organization, recover strength, continue production, improvise means, implement previously prepared plans.
4	Postattack	Continue production in support of "broken-backed warfare," continuous and dynamic reorganization of industry to meet requirements and necessary readjustments, continuous recruitment and training of labor force.

The preliminary survey, undertaken by management prior to the locating of a factory or branch installation generally will develop other requirements, but the above are minimal and they should be present in the findings (coordinated with local and regional Civil Defense and other interested agencies) of the factory site committee or individual responsible for the site selection.

The industrial labor force, composed of the free citizens of the United States, is one of the most vital and important elements in our national defense. Imbued with love of freedom and patriotically devoted to the American ideal, the American industrial worker with his technical ability has always met the challenge of war.

The advances and radical changes forced upon the military art by the application of nuclear devices to warfare are now the principal challenges faced by all men. No longer is warfare confined to the military. Nuclear weapons have made each factory bay a combat sector and the worker's bench the industrial equivalent of the combat infantryman's foxhole. The civilian population and the labor force furnished from that population are now in the front line!

Fearsome to contemplate, the potential of the new and untried weaponry as a force of destruction of human beings, their habitations, and their possessions, can be estimated only by speculation. But they are of such power that mankind could be erased from the earth by the searing blast and lethal fallout of nuclear devices delivered by aircraft or guided missiles.

THERE is some hope that universal fear of this possibility may inhibit the employment of these weapons, but this hope cannot be relied upon for the reason that the ideological and power conflict now raging among the nations of the world is involved with forces knowing no sense of the absolute value. In view of this terrible situation in which the world now finds itself measures must be taken to prevent the nuclear holocaust from happening. If this is not possible, man must plan to survive and the United States must continue to prepare for survival *with victory!*

In order to be prepared to replace those of the labor force lost through the initial nuclear missile salvos—the author has recommended that members of the Armed Forces of the United States be trained in an *industrial occupational speciality* connected with missile production. These Industrial Reservists would be returned to their parent unit upon completion of the industrial occupational specialty training. Refresher training would be conducted periodically for these Industrial Reservists in civilian factories engaged in defense-item production or the turning out of educational orders.

When and if the missile exchanges or volleys of nuclear warfare inhibit or frustrate the use of conventional type forces for combat these personnel therein, who have received the prescribed industrial training (in addition to their military skills) would be utilized immediately as replacements for those of the civilian labor force destroyed or incapacitated by the initial and subsequent attacks. Thus will the industrial weapon of the United States initiate and continue to support as a feasible plan the "broken-backed war" effort.

The foregoing suggestion is reiterated by the author for the maximum and efficient use of the combat manpower of the United States "to get on with the war" rather than accepting the best idea for their employment (after the primary salvos) recently advanced by a high-ranking professional, *who thought that they could be used to clean up the debris and help to supplement Civil Defense!*

The preliminary step in the implementation of the Industrial Reserve, as envisioned by the author, is to begin immediately (after joint agreements with industry and Defense and OCDM) to assign pilot detachments of military personnel to civilian factories, which are producing missiles and components, for training in basic industrial skills.

"Physical dispersal of present-day industrial plants, complexes, and stockpiles of raw and processed materials must continue to be accomplished on a time schedule agreed upon by management and government."

The advantage of this plan to the Nation and to the individual serviceman and industry is obvious. It will enable the United States to keep the missiles in the air for survival and victory.

Of paramount importance and almost as critical to our survival is the situation of the supply and stockpile of domestic and imported raw materials. Without them in sufficient quantities and in abundant reserve stocks the wheels of industry will not turn. Each industry in the United States must have a satisfactory wartime storage plan—not on paper, but in actual operation.

In this area of industry, management can show its imagination. It must, if it is to survive the impact of nuclear warfare with its total destruction, isolation, and marooning effects. The development of a wartime storage plan for raw and semiprocessed materials will, of course, be based upon several primary considerations; *i.e.,* dispersal, protection, availability of transportation (alternate and several modes) security, industrial and fabrication priorities, and, finally, the amounts of the materials on hand and the life expectancy of the source. (These inventories should be calculated at periodic intervals.)

A SATISFACTORY basic policy for the storage of certain materials will be to leave them in the crude or natural state—to remain underground as a material reserve and to be worked or processed as required. These materials, so reserved, will be considered part of the inventories previously mentioned.

Of utmost importance, in connection with the storage problem, is the matter of the safe and protected storage of finished products. Because of shipment "frustration" based upon assumed destruction of transportation facilities serving the factory and its area, finished products may be delayed; hence the plan must provide for this realistically. Here

again, the matter of space and dispersal of the items is of paramount importance. In an extreme situation, some products may have to be disassembled or broken down for dispersal.

All warehousing, to stand a chance of survival in a nuclear war, must be dispersed. Where dispersal is not feasible then storage must be underground or underwater. Obviously, those industries which have any relationship to national defense production must continue to modernize their storage facilities and programs to meet the assumed conditions of any future conflict.

THEORETICALLY, the percentage of manufacturing to be conducted underground will increase in direct proportion to the operational efficiency of the intercontinental ballistic missiles available to the nations of the world. As this condition is constantly changing and missiles are not now as perfected as the conventional jet bomber, the requirements for underground installations should be predicated also upon the need for protection from conventional aerial bombing attacks—with the difference that nuclear warheads will, in this writer's opinion, liberally replace the nonnuclear explosive.

Within each industry, all employees on executive and operating levels must know what they are to do, individually and collectively, in the event of an attack upon the United States. This information and instruction is provided in the current Civil Defense plans for national survival which have been prepared by all the States and the District of Columbia. Specifically, as far as personnel protection and survival are concerned, this instruction must take the form of prepared *standing operating procedures* which become operational automatically when an attack warning has been sounded or should an attack be made without warning.

Included within these plans are provisions for evacuation and shelter and continuity of the operations when feasible and necessary. *For any American industrial plant to operate, under the present conditions of international relations, for one day without such plans is sheer invitation to disaster and defeat.*

"The simultaneous receipt of intercontinental missiles in several geographical areas of the U. S. would have the effect of setting up a compartmentalized national economy."

State Civil Defense directors are prepared to advise and assist in these matters, and industrial firms in their areas should call upon them for assistance in drawing up and testing their standing operating procedures. For the management of a factory to render lip service to Civil Defense by providing signs in the hallways and corridors of the plant reading "Shelter Area" and to hold "coffee-break" meetings with tin-hatted employees wearing the CD armband means nothing in the event of the "real thing." In fact, such action may be categorized as something lying between the "valor of ignorance" and criminal negligence!

AT the factory floor level there must be a plan for the removal of movable machinery. For those machines not movable, some type of protective cover should be provided. This latter step is most necessary if the situation requires preattack evacuation of the labor force and the heavier machines must stay in place.

In the waging of "broken-backed warfare" machines are the weapons! The industrial soldier uses his machine to defeat the enemy by furnishing the combat forces with the weapons of war. In the military service, there is an old adage, which is equally applicable here—"The good soldier never loses his weapon."

In connection with the idea suggested above concerning the possibility of improvisation of some type of protective covering for shop machines—the writer noted in viewing the bombed-out Japanese factories that many of the lathes and milling machines had been severely damaged by falling debris from the roof areas, and fire and blast did their share of damage in the destruction of this vital equipment. If some form of covering had been in place much of this equipment could have been saved to fight another day.

IN summary, in order to be prepared to carry out the mechanics of "broken-backed warfare" American industry must continue to accomplish the following steps:

1. Physical dispersion of manufacturing complexes to alternate locations. Included in this requirement will be dispersal of component-making branches of the industry concerned.

2. Dispersal and protection from blast, fire, crushing, and radiation of raw or processed products. Included within this step will be the setting up and operation of dispersed storage caches.

3. Organization and implementation of an Industrial Reserve to include the personnel of the armed forces as indicated previously. These personnel would function to replace civilian casualties of nuclear warfare.

4. Continuation of the program of construction of underground factories and contiguous shelter for the factory labor force.

5. Coordination of the above steps toward industrial survival with the national concept of defense as promulgated by the Office of the President through the Office of Civil Defense Mobilization and the Department of Defense.

6. In order to carry out the above planning, American industry, through its various organizations, should initiate immediate acton for legislation authorizing the appointment of a Secretary of Emergency Industry (on Cabinet level) to be responsible for the implementation, supervision, and direction of the plan envisioned herein.

AMERICAN industry, with its technical superiority and production capability, has been challenged by the Communist forces in the world, which are dedicated to the task of "burying" us—according to Chairman Khrushchev. With our typical American directness and drive we should take immediate steps to ensure that this threat does not become an accomplished fact. This threat never will materialize if we are prepared to retaliate in kind (and we are) and if in event of attack we are able to shift into "broken-backed warfare"—and survive with victory!

Civil War Ordnance—VI

The Ship-Shore Duel

Yankee ironclads and Rebel forts both had their moments of triumph

W. T. Adams

ALTHOUGH engagements between land and ship-mounted ordnance played a part in earlier American history, the Civil War was unique in the manner in which it was characterized by almost countless duels between naval vessels and shore fortifications.

At that time the naval gunner was generally considered to be at a serious disadvantage when compared with his shoreside opponent, and strategists held that one gun properly emplaced in a shore fortification was the equivalent of five or ten guns of similar size mounted on board ship. As a result, naval vessels usually concentrated on destroying other vessels, and attacks on shore fortifications were comparatively rare.

The Civil War, however, forced the North to develop new tactics. The Union Navy was virtually unopposed at sea, and, in the over-all strategy of the war, blockade of the Southern coastline was of major importance. The length of seacoast involved, as well as the extensive nature of the inland river campaigns, made it mandatory that certain Southern strongholds be captured to serve as Union naval bases.

THE Union Navy was thus pitted directly against the Confederate Army in a duel of naval guns versus army artillery. In many respects the task was more difficult than that imposed by an action of ship against ship.

To a certain extent the naval operations against shore batteries represented a contest between land protection and vessel mobility and armor, for the offensive ordnance employed by both sides consisted of generally the same types of weapons. Many of the Confederate land batteries mounted naval ordnance confiscated when Southern forces seized the Norfolk Navy Yard and other Federal posts, and during the course of the war there were comparatively few major ordnance developments by either side.

Mr. Adams, a well-known student of military history, is the author of "Guns for the Navy" which appeared in the January-February 1961 issue of ORDNANCE.

Both Union and Confederate forces were woefully short of adequate weapons, and both ships and shore batteries were armed with an assortment of such guns as might happen to be available at the time they were needed. In many of the monitors, for instance, the two guns mounted in the same turret were of different sizes.

Throughout the war, however, the major weapon of both Union naval vessels and Rebel land batteries was the old muzzle-loading smoothbore—virtually the same gun that had fought the War of 1812. Although both rifled guns and breechloaders had been built prior to the Civil War, they were available in only limited numbers and played a relatively small role in the course of the war.

A primary reason for this, perhaps, was the fact that there had been little actual need for development of new weapons in the early part of the nineteenth century. During the period between 1800 and 1860 only two major wars had erupted (the War of 1812 and the Crimean War) and development of both offensive and defensive ordnance had proceeded at a leisurely pace.

Some important developments had occurred. Rear Adm. John A. Dahlgren of the United States Navy, for example, had done considerable experimental work in ordnance and gunnery. His most notable achievement in this field was design of the Dahlgren gun, wherein the size of the barrel matched the curve of pressures.

THE Dahlgren gun was still a muzzle-loading smoothbore, but its design produced a substantial gain in effective power and range with a minimum increase in weight. Thus it was ideally suited to mounting on board vessels and was extensively employed by the Union Navy. A large number also were used by the Confederates who mounted captured Dahlgrens in their shore fortifications.

Many older types of smoothbores such as the columbiads also were widely used by both sides throughout the war. The basic model of this gun had seen service initially during the War of 1812, and the Civil War versions were changed from those of the previous war in only minor respects.

Of the comparatively few types of rifled guns used during the war, the Parrott rifle was among the best known. Parrotts were made in various sizes—the 100-, 200-, and 300-pounders being most widely used. These guns were employed extensively on Union naval vessels but were not available in sufficient numbers to supplant the older smoothbores.

Perhaps the most significant nineteenth century ordnance development which did play a major role in the ship-shore engagements of the Civil War was the development in the early 1800's of explosive shells. These were used effectively with the old smoothbores, and it was soon discovered that they created their greatest havoc against wooden vessels.

The shell explosions produced a barrage of flying wood splinters that swept across a vessel's decks leaving unbelievable carnage behind. This, of course, added considerable impetus to the development of ironclad naval vessels.

In the initial stages of the war, the Union navy consisted entirely of wooden vessels, many of which were powered by sail alone. Such ships were ill-equipped to cope with land fortifications mounting heavy ordnance and firing explosive shells, and it was obvious that Union naval vessels would be at a clear disadvantage in attacking Confederate shore batteries.

Thus when Hatteras Inlet, on the North Carolina coast, was selected as the target for the first major naval attack in August 1861, the Union made every effort to provide overwhelming firepower for the naval forces.

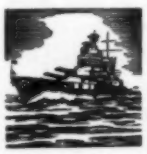
Two log and sand fortifications, Forts Hatteras and Clark, had been constructed by the Confederates in such position as to catch attacking vessels in a cross-fire when they attempted to pass through Hatteras Inlet. The Southerners were confident of their ability to repel any naval attack, and no doubt they would have destroyed any sail fleet attempting to force its way into the inlet.

BUT steam had given the warship and its ordnance a new and hitherto unknown mobility, and the Union fleet was able to pour a withering fire into the fortifications.

The Confederate surrender on the second day of the attack was a product of several factors, the most significant being the overwhelming firepower employed by the Union fleet, the relatively short range of the Confederate batteries (whose primary armament consisted of 32-pounder muzzle-loading smoothbores), the limited Confederate ammunition supply, and the severe battering that the log and sand walls took from an unusually accurate Union naval fire.

Almost as if to prove quickly that the first naval victory had been no accident, the North regrouped forces and attacked Port Royal, S. C., in November 1861. Here the entrance to the harbor was a narrow channel protected by two shore works—Fort Walker to the east and Fort Beauregard to the west.

Both forts were regarded as strong and well-equipped, and they were reported to mount twenty or more guns each. Facing them, the Union fleet under Rear Adm. Samuel F. DuPont consisted of fifteen vessels mounting over one hundred guns.



The naval attack was well conceived and flawlessly executed. Applying the same general tactics that had worked so well at Hatteras Inlet, DuPont's fleet moved within 600 yards of the forts during the attack, maintaining a tremendous barrage of fire and maneuvering on an elliptical course to confuse the gunners ashore. Within a matter of hours the forts were evacuated, and once again the Union Navy had successfully reduced a strong shore fortification with only minimal losses (eight men killed and twenty-three wounded).

More important, the North had proved that it was possible for naval vessels successfully to attack strong points along the Confederate coast. To the South the implications were clear, and in South Carolina troops about to leave for Virginia were ordered to remain for protection of their home State.

In the river war too, the Union naval forces began to prove that it was possible for naval ordnance to duel successfully with shore batteries. When General Grant prepared to attack Fort Henry in February 1862, he recognized the advantages of naval firepower and requested assistance of Flag Officer Foote, then commanding the river gunboat fleet.

"The Union Navy was pitted directly against the Confederate Army in a duel of naval guns versus army artillery."

Fort Henry, located in a bend of the Tennessee River so as to give its batteries a direct line of fire downstream, mounted 17 heavy guns and was classified as a strong fortification. Twelve of the guns (a 10-inch columbiad, a 60-pounder rifle, two 42-pound and eight 32-pound smoothbores) were mounted with an arc of fire covering the river and presented a formidable obstacle to any attacking naval force.

Foote considered his river gunboats a match for the fort, however, and proceeded to attack with four of them. Inasmuch as the ironclad bows were the most heavily armored portions of the vessel, it was decided to attack the forts bow on, even though the forward firing armament of the four vessels totaled only 11 guns.

OPENING fire at 1,700 yards, the vessels bore on toward the fort until they had closed the range to 600 yards. Both vessel and shore guns were fired with considerable accuracy, and the advantage of the gunboat armor became apparent after the first few rounds had been exchanged.

Although struck repeatedly by heavy shot from the fort, the three newer ironclads suffered little injury. Only the makeshift ESSEX was seriously damaged, and in the meantime the fort's firepower was reduced by the loss of its heaviest guns.

Early in the attack Fort Henry's only rifled gun had burst, and a short time later the 10-inch columbiad was disabled by a jammed priming wire in the vent. Other guns were soon disabled by the naval fire, and casualties mounted until, after an hour and a half of heavy fire, Fort Henry was surrendered.

Momentarily, at least, the victory at Fort Henry appeared to prove that river ironclads were quite capable of handling any shore fortification that did not possess overwhelmingly superior firepower. Within a week, however, Fort Donelson had proved otherwise. Donelson's guns were mounted on a bluff, giving them an excellent target in the relatively unarmored upper decks of the gunboats and presenting

a substantially more difficult problem to the Navy than had the previous attacks.

The fort was well armed, although not quite as strong in weight of metal as Fort Henry.

Facing the river attackers at Donelson were some twelve guns, two of which were relatively long range weapons (a 10-inch columbiad and a rifled gun variously described as a 32-pounder and a 6½-inch gun), while the remainder consisted of eight 32-pounder smoothbores and two short-range 32-pounder carronades.

THE fight was severe, and for a time it appeared that the gunboats would be able to drive Donelson's defenders from their guns. Then Confederate shells shot away the steering gear on both the ST. LOUIS and the LOUISVILLE, and both gunboats were swept downstream and out of the battle. The remaining vessels were unable to maintain a sufficiently heavy volume of fire to affect the fort's defenders, and they were eventually forced to withdraw.

Although damage inflicted by the gunboats assisted the Army in its ultimate capture of Fort Donelson, the repulse of the naval attack was a clear victory for the land batteries.

Thus it was apparent that neither land batteries nor river ironclads had a positive advantage in the river war. Armor and steam had neutralized the superiority of the shore position, and a slight change in the balance of power for either side might spell the difference between victory and defeat in any attack.

In the early part of the war, major naval attacks on shore positions were usually made with the goal of capturing or reducing the fortification as a result of naval gunfire. Such a course required that the attacking vessels remain under fire of land batteries for extended periods of time, and, despite a number of successful attacks, it appeared doubtful that vessels would be able to cope with all fortifications.

The Confederates were confident that their defenses of New Orleans made that city relatively immune to attack from the sea, and their optimism appeared justified. Forts Jackson and St. Philip, some seventy-five miles downriver from the city, were garrisoned by nearly a thousand men and mounted over a hundred cannon, a number of them of heavy caliber.

Beyond a doubt the two forts were entirely capable of stopping any sailing vessels that might attempt to work their way up the river, and even steam vessels seemed to have little chance of success. They would be able to move only slowly at best, when working upriver against the swift Mississippi current, and maneuvering of the type that had been so successful at Port Royal was impossible.

Despite Southern optimism, the Union determined to test the river defenses with a fleet of some 17 wooden warships mounting about 150 guns, plus 20 schooners, each mounting a 13-inch mortar.

To Farragut, who commanded the naval expedition, it was apparent that the mortars alone were incapable of reducing the forts. Equally, however, the idea of standing off and dueling against brick and masonry fortifications with his wooden vessels impressed Farragut as neither practical nor necessary.

It appeared far more logical to such a bold commander simply to pass the forts and continue on to New Orleans, leaving the forts to wither with their lines of communication cut. The plan was carried out with conspicuous success, and with comparatively little damage to the vessels despite severe fire from the forts as they passed.

If successes under such diverse circumstances as Hatteras Inlet, Port Royal, and New Orleans had shown that the Union Navy was capable of coping with coastal fortifications with reasonable chance of success, however, Charleston proved that a properly defended shore point could still hold out for extended periods against determined naval attacks.

Throughout almost the entire course of the war, Charleston was the target of sporadic attacks by Northern forces, with the Navy playing a major role. Prior to secession, Charleston harbor had been guarded by Fort Sumter, located on an artificial island in the harbor, Fort Moultrie on Sullivan's Island, and Castle Pinckney on near-by Folly Island.

Following secession the Confederates seized these defensive points, strengthened them, and, in addition, constructed new batteries facing the channel areas. Total defenses were reported to consist of one hundred and forty or more guns mounted so as to sweep the channel leading to the city.

This 7-mile channel, bordered by dangerous shoals, was hazardous enough at best without trained pilots to conn a ship; and with the addition of the guns and numerous torpedo mines planted in and about the channel area it became virtually impassable.

UNWILLING to attack such defenses with unarmored ships, the Union fleet was reduced, in effect, to an attacking force consisting at its strongest of seven monitors and the ironclad NEW IRONSIDES, mounting a total of thirty-two guns.

Although the monitors had proved their worth as fighting vessels and carried some of the heaviest ordnance used aboard naval ships of the day (11- and 15-inch Dahlgrens), their volume of fire was insufficient to cope with the tremendous barrage from the shore guns.

During an attack in April of 1863, for example, 139 rounds were said to have been fired by the monitors, while the forts responded during the same period with over 2,200 rounds. With such a disparity in firepower the monitors had little chance of damaging the shore batteries sufficiently so that a ship could move up the channel without being destroyed.

Under the circumstances, it was not surprising that Charleston fell finally only after Sherman's march into South Carolina forced its evacuation.

Thus it can be seen that the results of the war's countless ship-shore engagements were as varied as the tactics and weapons that were employed. Neither ship nor shore guns achieved a clear superiority, but the war did prove conclusively that the old tactical concepts concerning ship and shore guns no longer applied.

Defense Highlights: Monthly Review and Outlook

• **The Defense Budget.**—"The primary purpose of our arms is peace, not war—to convince all potential aggressors that any attack would be futile." On this note President Kennedy requested from Congress almost $2 billion more than President Eisenhower had recommended for new obligational authority for defense in fiscal 1962 but only about $1.3 billion more in expenditures.

The proposed new expenditure increases and reductions directly implement the President's policy for defense that can be summarized as follows: We must expect to take the first blow in a general war so we must concentrate our retaliatory power in the less-vulnerable nuclear weapons such as Polaris and Minuteman. We must be better prepared to win any limited war.

The large increases are $270 million for increasing the construction of Polaris submarines and accelerating development of the 2,500-mile, A-3 Polaris missile; $96 million to expedite Minuteman, improve its reliability, and double the capacity for its production; and $144 million to improve our air alert, air defenses, and early-warning systems.

To strengthen our conventional forces the following sums are recommended: $122 million to speed up limited-warfare research; $172 million to modernize airlift; $124 million for naval vessel modernization and construction of a new type of amphibious transport; $230 million for more helicopters, electronics, ammunition, and various land and sea weapons.

Manned aircraft are recognized as vital in limited war for target selection, pin-point bombing, and counter air action in a request for $70 million for new aircraft and modifications to the F-105.

To acquire and train more personnel for guerrilla warfare, Polaris submarines, and ground-alert crews and for additional training exercises, $104 million is listed.

To balance in part the heavy additional expenditures proposed above, the President recommended these reductions: eliminate the last two Titan squadrons (more of the less vulnerable Minuteman will be available); accelerate the phase-out of B-47 bombers; eliminate the Snark air-breathing missile (obsolete and concentrated at one exposed base); and cut back the B-70 to prototype development (by 1965 there will be quantities of ICBM missiles and B-52-type bombers armed with the Skybolt 1,000-mile ballistic missile).

Also dropped is the nuclear-powered aircraft program (the AEC will continue research to bring the "state of the art" within military operational feasibility); the Navy's Eagle-Missileer weapons systems (the Missileer aircraft was canceled previously), and the installation of Polaris in the nuclear-powered cruiser LONG BEACH (Polaris submarines are less vulnerable). Estimated savings in 1962 alone total $430 million.

• **Military Installations Closed.**—The Department of Defense has directed that seventy-three military installations be closed or reduced. This step was announced to Congress in President Kennedy's budget message as part of a continuing process "to review our nearly 7,000 military installations in the light of our needs now and in the event of an emergency." Even so, the political yowls are resounding throughout the Nation.

Overseas installations were not originally listed. Some of the fifty-two continental activities to be cut back include several Army arsenals and Ordnance depots; four Navy reserve fleet sites; the New Orleans Naval Station and 8th Naval District headquarters. Also included are eight Air Force plants located within industrial plants, and several small naval auxiliary air stations and Air Force bases including Presque Isle, Maine—along with the Snark missile.

From one to three years are allowed for phasing out with no savings expected in fiscal 1962 but thereafter about $220 million a year.

• **What Is Prosperity?**—The new budget requests include not only an additional $1.95 billion in new obligational authority for defense but $1.5 billion for health, education, and welfare and $1.5 billion for agriculture. The budgeteers guess the deficit will be $2.8 billion based on actual expenditures versus income (taxes).

Consider the following words of wisdom:

"You cannot bring about prosperity by discouraging thrift.

"You cannot strengthen the weak, by weakening the strong.

"You cannot help the wage earner by pulling down the wage payer.

"You cannot help the poor by destroying the rich.

"You cannot establish sound security on borrowed money.

"You cannot keep out of trouble by spending more than you earn.

"You cannot build character and courage by taking away man's initiative and independence.

"You cannot help men permanently by doing for them what they could and should do for themselves."

—*Attributed to Abraham Lincoln.*

• **Joint Combat Command.**—Plans for a new joint combat command combining the Strategic Army Corps and the Tactical Air Force are being prepared by Gen. Lyman L. Lemnitzer, Chairman of the Joint Chiefs of Staff, at the direction of Defense Secretary Robert S. McNamara for his consideration.

The Army and Air Force Chiefs of Staff had explored the

matter last year but arrived at no plan. Now to give us a more cohesive limited-war force it is proposed that STRAC be closely integrated with the airlift and fighter cover on which it depends for mobility and freedom of action. Over-all command is expected to fall to the Army.

• **"Unconventional Warfare."**—Guerrilla warfare training is being expounded as part of President Kennedy's build-up of our limited-war capability and to be ready to help our smaller allies combat Communist infiltrations. The 7th Special Forces Group (Airborne) at Fort Bragg, N. C., the headquarters force, has been increased by 500 men to a strength of 2,300 and its commander made a brigadier general. Front-line units are on duty in West Germany and Okinawa.

The men are volunteers, paratroop-trained, with prior military service, and many are at least bilingual. They are schooled in guerrilla, antiguerrilla, and unconventional warfare tactics, and are prepared to teach and lead large groups of allied guerrillas.

• **High-Flying Polaris.**—Polaris A-2 has attained ranges of over 1,500 miles in tests of the first several missiles. This second-generation fleet ballistic weapon gains the extra range by a longer charge (about two feet more in the first stage) and "several hundred" pounds of weight saving by use of a plastic-filament-wound second-stage case.

To attain a 2,500-mile range with the A-3 Super Polaris, the Navy is expected to call for similar construction of the first stage. Under consideration by Defense Secretary McNamara is a proposal to drop A-2 development and jump directly into a greater effort to perfect the A-3.

• **Changing the Air Guard.**—Nine Air National Guard Squadrons are being converted from fighter-interceptor or tactical reconnaissance roles to logistic support roles for which five squadrons will be equipped with C-97 Stratofreighters and four with aeromedical transports. Two interceptor squadrons are shifting from F-86L's to new F-100C Supersabres, and one interceptor squadron will be retrained to fly RB-57's for tactical reconnaissance.

• **Test-Ban Roadblocks.**—Our self-imposed test ban on small nuclear weapons continues into its third year for lack of agreement at the treaty talks in Geneva. Whenever progress appears possible the Communists throw in a new roadblock that would make an inspection system ridiculous. The British and United States representatives must wonder what will follow the Soviet proposals for veto power in the inspection agency and for nationals of each country to inspect themselves, both turned down by the other conferees.

These obstructive tactics have been pursued in spite of further concessions by the United States and Great Britain. In the meantime, officials responsible for our Nation's defense are increasingly concerned over the deterioration of small nuclear weapons development. They can foresee, as in the case of our missile program and limited-war capability, that endless procrastination will put us at a disadvantage.

There is an irreducible time factor that no amount of money and manpower can overcome. In rocket launchers, we will match only present Soviet achievements in four years. This program is of no immediate military significance. However, as our nuclear weapons obsolesce, our defense and even our national existence are jeopardized.

It is tragic that decisions in this area are not being made with the same forceful alacrity that they are in other areas of national defense.

• **Satellite Rocket Lag.**—Hugh Dryden, Deputy Director of the National Aeronautics and Space Administration, told Congress at earlier hearings that there was a satellite launching rocket "lag" of four to five years vis-a-vis the Soviets. To close this gap, Congress has been requested to authorize $74 million additional for the second-generation Saturn C-2 rocket which should advance its test date about a year to 1964.

The Centaur rocket program also could be advanced several months if Congress authorizes a request for $25 million additional. Centaur is planned as a general utility launcher for payloads around 8,500 pounds at low orbit; first test is scheduled for the last quarter of 1962.

• **The Ordnance Museum.**—There has been issued recently a long-overdue monograph on the Aberdeen Proving Ground Museum. It is the work of Karl F. Kempf, historical officer at Aberdeen and long identified with the museum itself. Although in mimeograph form, it is an accurate record of a most important era of American arms development. The monograph deserves more permanent form as does the museum itself.

For many years recognized as the handiwork of one individual, the Aberdeen Museum is associated always with the name of the man who is a genius in his own right and who has given a great part of his life and talent to the museum and its evolution. He is Col. G. Burling Jarrett, United States Army Reserve (Retired) who for years has directed the museum and has brought it to its present high state of perfection.

The significance of this collection of ordnance cannot be overestimated. It is a visual proof of the ingenuity of arms designers, the continuing increase of firepower and range, and the application of new engineering principles to the art of defense.

The Aberdeen Museum deserves to be much better known by the American public, for it tells in visual form—and better than any other medium—the great need of a major nation for constantly improved defense equipment.

It is to be hoped that the day is not far distant when the Aberdeen Museum can be more adequately housed, where its stupendous collection can be displayed to best advantage, and where its lessons can be pondered as befits their importance. This collection is not only a record of the past—it is a lesson for the present and the future. The exhibits at Aberdeen are evidence of our national dependence upon weapons progress for survival.

Nuclear *and* Conventional Forces

An Editorial

THE steps already indicated by the Department of Defense for strengthening our conventional forces are heartening. They were long overdue. The Army, Navy, and Marines have been pleading for it for years on end. Now it looks as though Defense and Congress will act to train and equip with the latest types of arms those major units required to meet our military needs. Thus will we return to the "doctrine of balanced forces."

Discussions that have arisen about building up our conventional military forces frequently regard such forces as an alternative to nuclear—or unconventional—forces. Commentators often ask: Should we have the one *or* the other?

However, it is by no means a case of shall we be ready for limited *or* unlimited war with conventional *or* unconventional weapons. The thinking as expressed in the semantics is all wrong. The plain fact is we need nuclear *and* conventional weapons.

In the years since World War II, our losses of people and countries to Communism have occurred despite our nuclear capability. Without the will to use nuclear weapons we must have conventional forces to meet the challenges of Korea, Viet Nam, Lebanon, Tibet, the Congo and Laos. *And we need both kinds in ample quantities in instant readiness to meet all possible military demands.*

AS to our capability of waging nuclear war, many analysts believe that we have weakened our position immeasurably by failing to resume nuclear tests. We are indulging in conferences with Communist spokesmen whose actions always speak louder than their words. We would be well advised to resume nuclear testing without delay in order that no more time be lost.

But at least our arsenal of atomic and nuclear warheads is in readiness for retaliation and could be used—as regrettable as such use would be.

As to our capability of waging conventional war we are, in the opinion of military experts, not now equal to our international commitments. If we are to continue to be as magnanimous as our obligations now require we must face up to the task; otherwise an unconscionable adversary will seize the initiative and perchance the victory.

There are theories aplenty about the nature of another war. Many experts hold that the nuclear stalemate will mean more and more wars like Korea. Others, less cautious and less realistic, uphold the belief that massive nuclear attack will be the way to peace.

Conventional war is not only possible—it is here. It exists in the stalemate that still continues in Korea after eight years; it is in the impasse that still persists in Berlin after fifteen years; it is in Laos and Indonesia; in the Western Hemisphere and on the African Continent. The need is pressing for trained and equipped land divisions; for manned ships and submarines; for aircraft and missiles; and above all for the up-to-the-minute armament required by these conventional forces.

One of the best qualified spokesmen on this subject is Lieut. Gen. James M. Gavin. Speaking to the members of the American Ordnance Association a few years ago he summarized his philosophy on the subject:

"What must the Western world do about limited war? We must respond rapidly—this is of the essence. And we must have *mobility*, whether by air or sea—and it will certainly take both. We must have means adequate to the task. And if there is any doubt about the type of opponent with whom we must deal, I refer you to the display in Red Square on last November 7th. Combat concepts of World War II or Korean vintage will be disastrous.

"We must think of tomorrow and the needs of tomorrow, and these spell out in simple terms great dispersion and great mobility with surface-to-surface missiles extending the range of ground fire hundreds and hundreds of miles, surface-to-air missiles to guarantee the independence of operations on the surface of the earth, and, finally, nuclear weapons in every echelon of the military establishment where they can be usefully employed—nuclear weapons of precise yield, small in size where necessary, and in abundance.

"All the foregoing must be matched with significantly greater mobility than anything we have thought of in the past. For it is in mobility that innovation will be found. Tactical and strategic innovation is as essential to survival as the hardware of combat itself. This obviously is quite an order and suggests clearly a sizable investment of our national product in weapons systems. I wish that I could counsel some other course. I would prefer to do so if I could in all honesty, but I cannot.

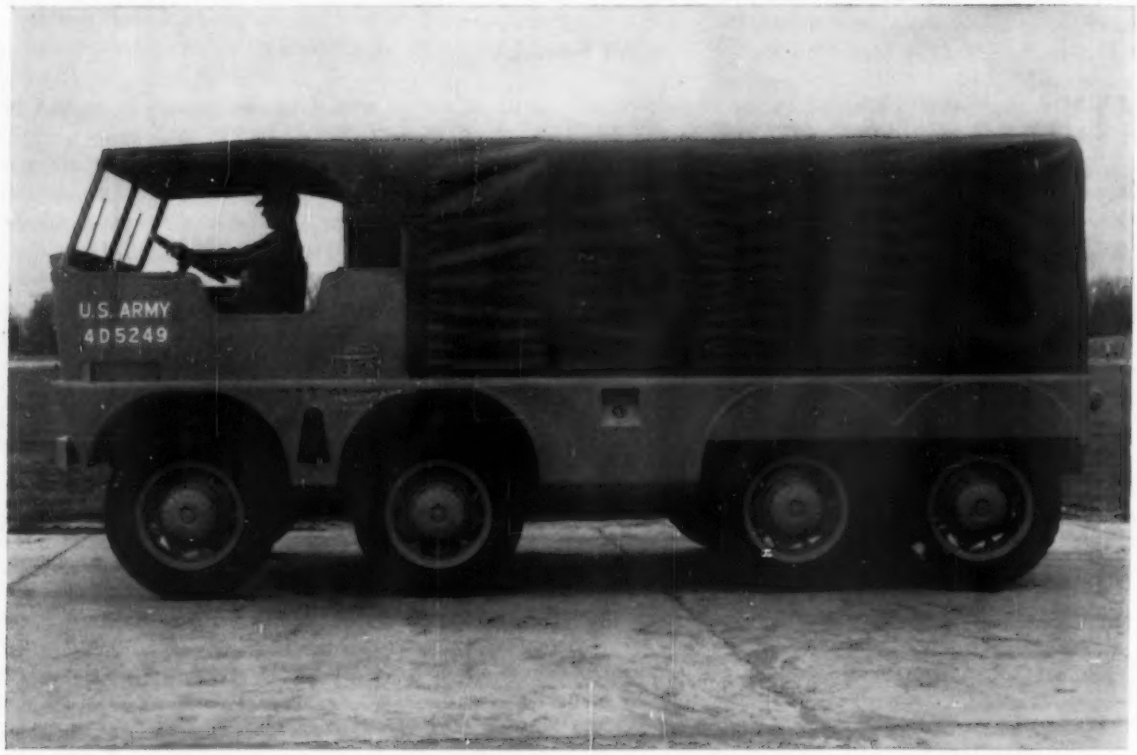
"Sooner or later we must face up to this fact—we must be *for* something more than merely 'against Communism,' and our weapons systems must reflect what we are for.

"Obviously, they must have a capability of doing more than merely dealing with limited war. There are limitations on limited war, and capability to deal with limited war must not exclude from our thinking the need for far greater capability" (ORDNANCE, March-April 1958).

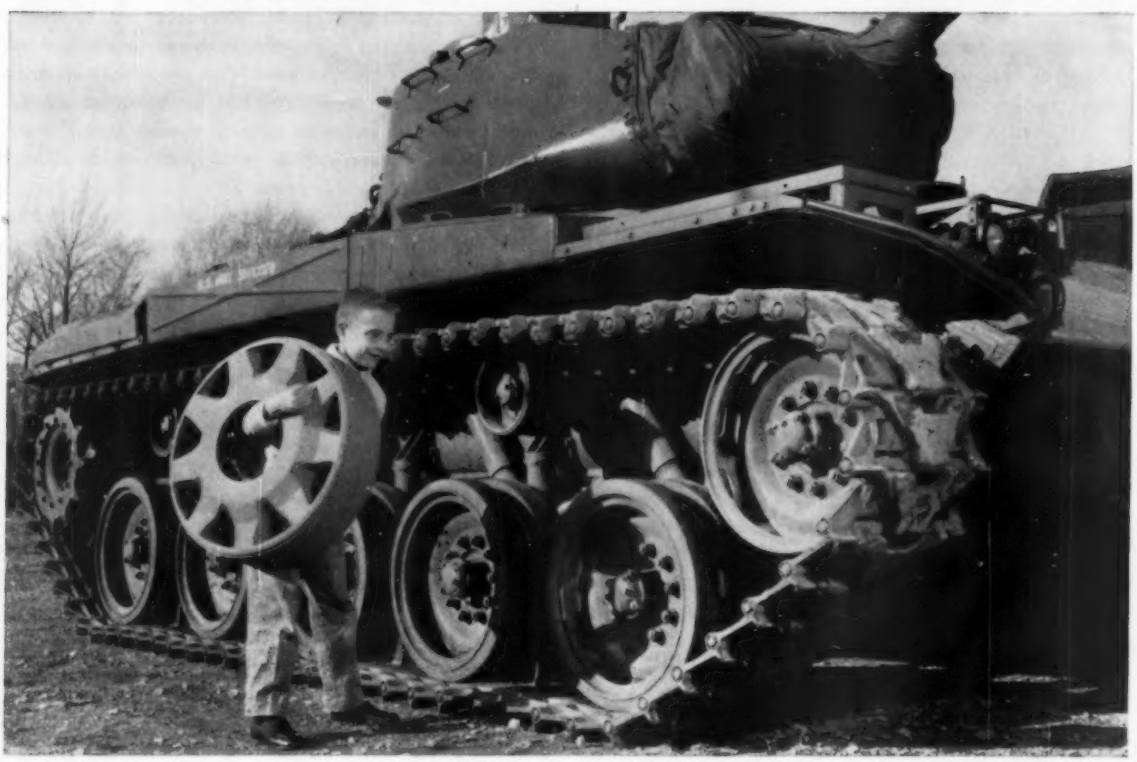
THE next test will come when the Congress is requested to bolster our conventional forces. It will be more than interesting to observe the outcome. It will indicate clearly whether America and her allies "have failed to rally their moral and material strength sufficiently to enhance and extend freedom and make it prevail over tyranny."

There is no indication that the Communists will hesitate to use either type of warfare. Each must be kept in the highest state of readiness for the kind of conflict the Communists choose to fight, for only they will determine the time, the place, and the means.

What's New on Wheels



The XM521 amphibious research vehicle, above, was designed by Detroit Arsenal to provide maximum swimming ability with minimum weight. It can carry 5,000 pounds at speeds up to 55 m.p.h. and will not sink, even when filled with water. The lightweight plastic tank wheel, shown below held by a child, is being developed in the hope of replacing the conventional wheel.



ASSOCIATION AFFAIRS

New Service Secretaries Meet With A.O.A. Executives In Washington

A distinguished delegation of the new Secretaries in the Defense Establishment were guests of the Executive Committee of the American Ordnance Association at luncheon in Washington, March 9, 1961.

The occasion was the annual spring meeting of the Committee which had assembled earlier that day at the Army-Navy Club to review and adopt plans for the Association's affairs during the coming year. J. E. Trainer, executive vice-president of Firestone Tire & Rubber Company, Akron, Ohio, who became president of the Association January 1, 1961, presided at the meeting and at the luncheon. Among the distinguished guests were:

Hon. Roswell L. Gilpatric, Deputy Secretary of Defense; Hon. Elvis J. Stahr, Jr., Secretary of the Army; Hon. Eugene M. Zuckert, Secretary of the Air Force; Hon. Arthur Sylvester, Assistant Secretary of Defense—Public Affairs; Hon. Stephen Ailes, Under Secretary of the Army; Hon. Richard S. Morse, Assistant Secretary of the Army—Research and Development; and Hon. Lyle S. Garlock, Assistant Secretary of the Air Force—Financial Management.

The purpose of the luncheon was to welcome the members of the new Secretariat and to extend the full cooperation of the Association—its fifty-four Posts and Chapters, eighty-five Technical Divisions and Sections, and its five publications—in advancing the weapons preparedness of our country.

A highlight of the luncheon was the presentation of a check for $581.70, payable to the Air Force Aid Society, which was accepted on behalf of that society by Secretary Zuckert of the Air Force. Later the Secretary presented the check to Maj. Gen. Howard C. Davidson, Director of the Air Force Aid Society. A photograph of the ceremony appears on this page.

Representing the military services were: Lieut. Gen. John H. Hinrichs, Chief of Ordnance, United States Army; Rear Adm. Paul D. Stroop, Chief, Bureau of Naval Weapons; Rear Adm. W. A. Schoech, Deputy Chief, Bureau of Naval Weapons; and Maj. Gen. Chester R. Allen, Quartermaster General, United States Marine Corps.

Representing the Ordnance Association at the luncheon were the following officers and members of the Executive Committee: Mr. Trainer, Lieut. Gen. Levin H. Campbell, Jr., Vice Adm. George F. Hussey, Jr., Harvey C. Knowles, Col. Henry N. Marsh, Louis Polk, Maj. Gen. James D. McIntyre, and Col. Albert W. Gilmer.

The following national officers of the Association also were in attendance: Adm. Albert G. Noble, Stewart L. Magee, and Maj. Gen. Russell L. Maxwell. The following members of the staff of national headquarters also were present: Leo A. Codd, executive vice-president; Capt. J. M. P. Wright, staff director for Posts and Chapters; Maj. Gen. E. P. Mechling, staff director for technical operations; and Roger E. Lewis staff director for publications.

Air Force Secretary Eugene M. Zuckert, left, presents A.O.A. check for Air Force Aid Society to Maj. Gen. Howard C. Davidson, director of that organization.

The luncheon was entirely informal. Mr. Trainer gave a brief outline of the aims and purposes of the Association which is published on page 785.

The donation to the Air Force Aid Society follows a practice of long standing by the Association as to the proceeds from all its annual meetings. This custom prescribes that all excess of income over expenditures is donated to the charitable organization of that military service which acted as host to the Association at its meeting. The presentation was made by Mr. Polk, past president of the Association, under whose regime the meetings were held.

In a gracious response, Secretary Zuckert expressed the thanks of the society and remarked that the United States Air Force was doubly honored. "In addition to your kind contribution, we were most happy to be allowed to serve as your host at the last annual meeting," he said.

The principal business to come before the Executive Committee at its session earlier had to do with the financial status of the Association and the budget for 1961. The Committee also decided to designate the fund formerly known as the Crozier Scientific Fund as the Crozier Building Fund.

The fund consists of $150,000 received under the will of the late Mrs. William Crozier, widow of Maj. Gen. William Crozier, Chief of Ordnance of the United States Army—1901-1918. It was her wish that Crozier House, the residence of General and Mrs. Crozier, be used for the Association's national headquarters.

Despite arduous efforts on the part of the Association and its counsel, permission to use the property for this purpose was denied by the zoning authorities of the District of Columbia, and the property subsequently was sold. The action of the Committee is an effort eventually to comply with the wishes of the donor and also provide adequate permanent headquarters for the Association in the Nation's Capital.

The ultimate attainment of this objective will depend on further additions to the fund which will be made from annual surpluses from operations of the Association whenever there are such surpluses and, it is hoped, from further benefactions from members and friends.

At some appropriate time in the future it might be desirable to have a formal appeal to members for this purpose. Meanwhile, it is a project well worthy of members, especially in bequests by those whose loyalty to the Association's ideals would thus find further expression.

Committees were appointed for the nomination of national directors and members at large of Council for terms

beginning January 1, 1962, and for the selection of candidates to receive Association awards during 1962. Suggestions from members for consideration in both areas will be welcomed by the committees.

Yankee Post Hears Panelists Discuss Procurement Practices At Meeting And Seminar

The winter meeting and technical seminar of the Yankee Post was held on February 2nd at Avco Research and Advance Development Division, Wilmington, Mass. Over 300 members assembled for the dinner and seminar.

The feature of the meeting was the panel of three key speakers headed by Albert C. Lazure, chief legal counsel of the Army Ordnance Corps, and including John P. Galimberti, comptroller, Boston Ordnance District, and Ernest F. Leathem, former assistant to the president of Raytheon Company.

The panel members discussed procurement practices brought about by revisions in the Army Special Procurement Regulations and the new regulations on proprietary rights. Specific subjects were: subcontracting, cost certification, patent rights in respect to independent research and development programs, advance understandings of specific cost elements, and the procedure for negotiation of independent research and development programs.

Early arrivals toured part of the Avco facility that is dedicated to the solution of theoretical and practical problems in advanced systems development. These members saw some of the experiments in progress related to extremely high temperatures, materials, aerodynamic and structural problems, and electronic instrumentation.

Steering Committee Of Mine Section Meets At The Naval Ordnance Laboratory

The Steering Committee of the Mine Section, Underwater Ordnance Division, met at the call of its chairman, J. McWilliams Stone, DuKane Corporation, St. Charles, Ill., at the Naval Ordnance Laboratory, White Oak, Md., on February 1st.

Representatives of Navy installations presented papers covering activities concerning mines and discussed the research, development, engineering, production, inspection, and logistics of this matériel. A detailed report cannot be made as final decisions have not yet been reached.

The Section also considered several problems which have been received from the Bureau of Naval Weapons. It is anticipated that action will be taken by ad hoc committees prior to the next meeting of the Section.

Admiral Raborn Addresses Anniversary Celebration Of The Los Angeles Post

The Los Angeles Post held one of its most magnificent annual meetings to celebrate its twenty-fifth anniversary and to honor Vice Adm. William F. Raborn, Jr., director of the Navy's Polaris program.

A distinguished group of members and their ladies assembled early on the evening of February 9th in the new Beverly Hilton Hotel to welcome the guest of honor.

In honor of the 25th anniversary of the Los Angeles Post, the Hon. Norris Poulson, Mayor of Los Angeles and a Post director, right, presents A.O.A. Week proclamation to A. E. Austin, Jr., Post director, while Frank Mayer, newly installed Post president, left, and Vice Adm. W. F. Raborn, Jr., guest of honor, look on.

The presiding officer, Aubrey Austin, chairman of the Post's board of directors, called on Lieut. Col. Emanuel Carlsen, Army chaplain, for the invocation and then led the assembly in the pledge of allegiance to the flag.

As the dessert was due, the guests were electrified by the appearance of an enormous birthday cake commemorating the twenty-fifth anniversary of the Los Angeles Post which was established in May 1936. While the birthday cake was spotlighted on the stage, a parade of waiters, marching to a lively tune, circled the ballroom each bearing a portion of the dessert or a flaming dish of the sauce.

Mr. Austin opened the meeting by thanking the hotel for its recognition of the Post's silver anniversary and then introduced Frank Mayer, the incoming president, who assumed his office and the chair. Mr. Mayer introduced the guests at the head table and other distinguished members in the audience and then announced that Mayor Poulson of Los Angeles had proclaimed the week of February 5th as American Ordnance Association week in Los Angeles.

Capt. J. M. P. Wright from A. O. A. headquarters greeted the members on behalf of the national Association, congratulated them on their twenty-five years of activity, and presented a certificate of appreciation to C. C. Gabrielson for his outstanding leadership of the Post.

Mr. Mayer introduced the guest of honor, Admiral Raborn, who opened with a brief note of appreciation for his reception. He praised the Association for the unselfish and patriotic motives that guide it and for its "all-partisan" attitude toward the military services. He said he always had been impressed by the "rationality" of the A. O. A. membership.

The Admiral introduced his subject with a film that summarized the development, production, and testing of Polaris. The final portion of the film showed the proceedings aboard the submarine GEORGE WASHINGTON as it made the first successful full-underwater Polaris firings just

before embarking on its first patrol.

With this exciting background the admiral explained in more detail the proposed utilization of the missile and the Navy's plan for its Polaris fleet of submarines. It was an extremely able and illuminating presentation of this powerful and effective weapon.

During the proceedings, Mr. Austin also extended his gratitude to the men who had labored extensively to make the meeting such a success including Robert W. Reniers, Richard T. Cowden, John S. Schumann, Dan O'Connor, and Mrs. Ruth Cousens.

Guests at the head table not previously mentioned were: Col. John R. Medberry, Commanding Officer, Los Angeles Air Procurement District; Col. Paul H. Scordas, Commanding Officer, Los Angeles Army Ordnance District; Vice Adm. Clarence E. Ekstrom, Commander, Naval Air Forces, Pacific Fleet; Rear Adm. Robert L. Townsend, Commander, Carrier Division; Rear Adm. John B. Pearson, Jr., vice-president, North American Aviation, Inc.; Samuel K. Rindge, Citizens National Bank of Los Angeles; and K. T. Norris, Sr., chairman of the board, Norris-Thermador Corporation.

Plastics Section Members Brave Snow To Hold Meeting At Picatinny Arsenal

Picatinny Arsenal, N. J., was the site of the first meeting of the Plastics Section, Materials Division, on February 8th. Section Chairman E. O. Hausmann, led the meeting of forty-two members and consultants who attended despite a blizzard.

The Section members were greeted by Maj. Gen. W. K. Ghormley, commander of the Ordnance Special Weapons-Ammunition Command, and Col. R. R. Klanderman, the commander of Picatinny Arsenal. The chairman of the Materials Division, W. J. Reitze, Esso Standard Oil Company, New York, N. Y., also addressed the Section to reaffirm the importance of plastic items in today's ordnance.

A series of technical papers on research programs and present and anticipated uses of plastics and adhesives was presented. Additional papers were given on packaging and the use of plastics in packaging ammunition.

The speakers, all from the Feltman Research Laboratories (FRL) of Picatinny Arsenal, were N. J. Powers, J. Scavuzzo, N. J. Bodnar, G. R. Buck, and H. Weiner.

A description of the year-old Plastics Technical Evaluation Center (PLASTEC) was given by H. E. Pebley, Jr. J. Matlack, FRL, led the technical sessions while Dr. M. H. Bigelow, Allied Chemical Corporation, New York, N. Y., conducted the question periods.

Plans for an early fall meeting at the Wright Air Development Center, Ohio, were announced, but full plans are not yet available.

Examining plastic ordnance items at Plastics Section meeting are, left to right: J. D. Matlack, chief, Plastics and Packaging Laboratory, Picatinny Arsenal; Col. R. R. Klanderman, arsenal commander; E. O. Hausmann, chairman, A.O.A. Plastics Section; and Maj. Gen. W. K. Ghormley, commanding general of the Special Weapons-Ammunition Command. Forty-two members and consultants attended this inaugural meeting.

Executive Board Of The Electronics Division Meets To Arrange Fall Program

The Executive Board of the Electronics Division met at the call of the chairman, Maj. Gen. F. L. Ankenbrandt, U.S.A.F. (Ret.), Radio Corporation of America, Camden, N. J., in Philadelphia on February 17th. The principal purpose of the meeting was to initiate planning for the fall meeting of the whole Division.

The board adopted a suggestion to meet in the mid-Atlantic area, preferably at Langley Air Force Base, Va. It is planned to hold the meeting on September 18-20, 1961.

Col. R. V. Fite, U.S.A. (Ret.), Burroughs Corporation, Paoli, Pa., was introduced as the new chairman of the Airborne Electronics Section. He replaces J. D. Woodward, Radio Corporation of America, Camden, N. J., who had to relinquish the post because of increased pressure of business.

Replies have been furnished to the Ordnance Corps on several problems submitted to the Division at the Santa Barbara meeting last spring. It is planned that the remaining problems will be answered soon.

The board reviewed a statement of Section capabilities on hand and decided to use this format for the other two Sections.

After further discussion emphasizing the importance of security at classified sessions the meeting was adjourned.

Dr. D. E. DeBeau Discusses Operations Research At Florida Post Meeting

The annual dinner meeting of the Florida Post was held at the Eglin Air Force Base Officers' Club on February 6th. Col. H. J. Crumly, retiring president, called the meeting to order and introduced Maj. Gen. Robert H. Terrill, Commander, Air Proving Ground Center, the national Council member of the Florida Post.

General Terrill discussed briefly the highlights of the A.O.A. Industrial Preparedness meeting in New York City on December 7, 1960, specifically mentioning the superior caliber of the attendees and the excellence of the presentations. After reading the mission of the A.O.A., General Terrill thanked Colonel Crumly for his exceptionally fine efforts during his 2-year term as Post president and installed Col. H. M. West, Jr., Eglin Air Force Base, as the incoming president of the Post.

Colonel West accepted the gavel from General Terrill, called attention to the annual report distributed to each member, announced that he planned to call a directors' meeting each month, and indicated that action would be taken to increase attendance at the monthly general meetings.

The guest speaker of the evening, Dr. David E. DeBeau, assistant manager of the Operations Research Division, North American Aviation, Inc., gave an interesting and informative briefing on the philosophical aspect of "Operations Research." He explained that operations research was a relatively new field of effort, since activity was almost nonexistent fifteen years ago, but currently the Army, Navy, Air Force, and industry are increasing their programs in this area significantly.

He noted that several educational institutions, such as Case Institute and Carnegie Tech, presently are offering courses in operations research.

Dr. DeBeau pointed out that the methodology or techniques utilized in operations research are not original but have been borrowed and include various theories, such as "game," "waiting line," "simulation," "inventory," and "linear programming." He chose as a concise definition of operations research, "intellectual share cropping," with the prime objective of providing the "decision maker" with basic facts which permit him to select the one best course of action from among several alternatives.

"Man In Space" Draws Record Turnout To Capital Cities Post Dinner Meeting

A record attendance turned out for the Capital Cities Post winter dinner meeting to hear Fred Vick, Deputy Director of Missile Programming, U. S. Air Force, present "Man in Space"—an arresting account of Project Mercury and the coming conquest of space.

Nearly 300 Post members and guests jammed Schenectady's Edison Club for the March 1st affair which also included a display of the Army's new M14 rifle, the infantry's atomic Davy Crockett, and an exhibit of the Army family of missiles, all made available by Watervliet Arsenal, Watervliet, N. Y.

Post President William Stuart, arsenal executive officer, was toastmaster and introduced Mr. Vick who described the nature of space and how man proposes to probe its vast expanse; outlined the the physical and psychological problems faced by the astronauts; and explained many of the natural and technical phenomena most likely to be encountered in space.

Climax of the program was a film, "How Many Stars," a stunning depiction of the star-spangled reaches of the universe.

Frederick C. Kirwin, Watervliet Arsenal, was chairman for the dinner meeting. He was assisted by Robert Bergner, Alco Products, Inc., Schenectady, N. Y.; A. E. O'Kane, General Electric Company, Pittsfield, Mass.; and John E. Benson Jr., Watervliet Arsenal.

Fred Vick, left, guest speaker at the Capital Cities Post dinner meeting, describes model of a Nike missile to John G. Schatz, Watervliet ordnance engineer, and his son John, who were among the nearly 300 attending the annual affair.

Committee On Technical Publications Meets In Washington To Plan Program

The new A.O.A. Special Committee on Technical Publications held an organizing meeting in Washington on February 28th. Chester W. Lytle, president of the Lytle Corporation, Albuquerque, N. Mex., was designated chairman of the committee by Col. H. N. Marsh, A.O.A. vice-president in charge of technical operations.

The meeting was opened by Maj. Gen. E. P. Mechling, U.S.A.F. (Ret.), staff director for technical operations. He reviewed the purposes and mission of the Association, the background of the formation of this committee, and outlined certain problem areas and possible activities.

Consultants from Defense agencies discussed the many problems existing in the areas of technical publications and described the activities of their agencies and the status of some of their projects.

Discussion at length indicated the need for four standing subcommittees. These will be in the area of maintenance, supply, operations, and training. In addition, two ad hoc committees were approved—one to define the levels of technical writing and the other to review reports on technical publications which had been submitted earlier by other organizations.

Following these discussions, Colonel Marsh appointed Mr. Lytle chairman of the Committee. Other members present expressed their respective interests in the particular subcommittees noted above.

A target schedule was established which planned to see the subcommittees staffed and organized during March, Government consultants obtained during April, and a meeting of the full committee held on or about April 25th.

G. T. Willey Addresses Aberdeen Post Meeting At Martin Company Plant

The Martin Company, Baltimore, Md., was host to the Aberdeen Post at its quarterly meeting on February 15th. Post President Charles D. Nitchie headed the group of almost 200 members who assembled at the Martin plant restaurant for the dinner meeting.

The guest speaker, G. T. Willey, vice-president and general manager of Martin's Orlando Division in Florida, addressed the meeting on "Value Analysis Engineering as Viewed by Top Management." He introduced his subject by emphasizing the need to reduce costs in all areas of American economy and related

this directly to survival in this day and age. However, with this reduction in cost must go an acceptable degree of effectiveness of the product and reliability of its performance.

This reduction in cost is achieved, Mr. Willey pointed out, by omitting from the final product those components which are not essential to its functioning. Those components which must stay are simplified to the greatest extent possible.

In this connection, realistic specifications were shown to be a vital part of cost reduction. While the product itself is a worth-while target for value analysis engineering, each supporting service must also be examined in this light. The likelihood of such activities such as procurement, housekeeping services, and the like driving costs upward was shown to be very real.

Mr. Willey represented value analysis engineering as a frame of mind, an attitude, a way of life, rather than an occasional spurt of effort in certain selected areas of the manufacturing process.

He placed great insistence on the fact that the impetus for this way of life must come from top management itself. It must come from the very top man, and it must extend all the way to the last production worker, the last sales representative, the last customer-service agent. In addition, he emphasized that it must make its appearance very early in the design stages where the real savings can be realized.

Mr. Willey concluded by showing several slides of production at the Martin Orlando Division and citing examples of application of his theory to his own operation. As further support of the effectiveness of what he preached, he cited several specific examples of savings which had been realized within the past few years.

Admiral Beardsley And General Demler Address Meetings Of Washington Post

The Washington Post's March luncheon meeting was a special affair jointly sponsored by A.O.A. headquarters on March 17th at the Willard Hotel. There was an impressive array of Defense Department officials assembled to hear the guest speaker, Vice Adm. George F. Beardsley, Chief of Naval Material.

Millard C. Richmond, Post president, introduced the guests and the toastmaster, Adm. Albert G. Noble. Admiral Noble, a former Chief of Naval Material, first introduced Rear Adm. Murray Royar and Vice Adm. Edward W. Clexton who also have served with distinction as Chiefs of Naval Material. After recounting the background of the establishment of ONM late in World War II, Admiral Noble introduced the guest of honor.

Admiral Beardsley in his report on the management aspect of the Navy's program noted seven areas in which he was striving for improvement. He said that fifty per cent of the procurement funds had been obligated and that he expected to execute most all of them by July 1st. In making procurement by letter of intent, the conversion time to a definitive contract is to be trimmed to 180 days.

The admiral especially emphasized the competitive nature of negotiated contracts and said, "If this country wants sophisticated ships, aircraft, missiles, and other hardware developed, produced, and put into service use with a minimum of delay, the negotiated contract, in one form or another, is the most satisfactory means of achieving this end."

Then as early as possible advertised procurement should be instituted for which the Office of Naval Material seeks to speed up firmness of requirements and reduce the numbers of design changes. He also discussed the need for early establishment of firm prices.

He noted the lessened percentage of small-business prime contracts and stated that to reverse this trend he would make "increased use of breakouts and increased publicity on proposed procurements, including advanced publicity for research and development procurements."

Admiral Beardsley further stated: "We are reducing our investment in facilities and machine tools consistent with mobilization needs. Quality assurance is a mutual responsibility of the Navy and its suppliers, with the Navy monitoring quality control and suppliers giving it increased emphasis. The backlog of contract terminations must continue to be reduced—a step of mutual advantage to the Navy and to industry."

Guests at the speakers' table were: W. J. Reed, vice-president, Washington Post; Rear Adm. William A. Schoech, Deputy Chief, Bureau of Naval Weapons; Maj. Gen. R. L. Maxwell, member, Board of Directors, A.O.A.; Rear Adm. James W. Boundy, Chief, Bureau of Supplies and Accounts; Rear Adm. Philip W. Snyder, Vice Chief, Naval Material.

Also, James N. Davis, Deputy Assistant Secretary of Defense, Installation and Logistics; Merritt H. Steger, General Counsel, Department of the Navy; Hon. Kenneth E. BeLieu, Assistant Secretary of Navy, Material; Stewart L. Magee, regional vice-president, A.O.A.; Rear Adm. Daniel F. Smith, Jr., Chief of Naval Information.

Also, Rear Adm. E. F. Metzger, Assistant Chief, Bureau of Naval Weapons; Col. Aubrey E. Austin, Jr., chairman of the board, Los Angeles Post, A.O.A.; Brig. Gen. Paul L. Barton, Director of Logistics Plans, U.S.A.F.; and Rear Adm. Miles Hubbard, Assistant Chief of Naval Operations, Logistics.

At the previous Washington Post meeting on February 16th the guest of honor was Maj. Gen. Marvin C. Demler, Director of Aerospace Systems Development, Headquarters, U.S.A.F. There was a broad cross section of officials on hand representative of all research and development offices of the Department of Defense and the armed services.

General Demler delivered a complete and most impressive account of the Air Force aerospace program. He described both the progress and plans for the manned vehicles such as the X-15 and Dyna-Soar and the missile and satellite program. He pointed with particular pride to the impetus and advance scheduling of the Minuteman missile confirmed by the recent test flight of the first vehicle.

A most interesting part of his presentation was a 20-minute film in sound and color on the numerous recent tests of the Air Force's large array of military missiles including ICBM's and air-to-surface and air-to-air weapons.

The presiding officer was Post President, Millard C. Richmond and guests at the speakers' table were: W. E. Haines, Post vice-president; Brig. Gen. R. D. Curtin, Director, Office of Missile and Satellite Systems, U. S. Air Force; Rear Adm. W. A. Schoech, Deputy Chief, Bureau of Naval Weapons; Brig. Gen. R. L. Wassell, Director of Research and Technology, U. S. Air Force.

Also, Rear Adm. T. F. Connolly, Director of Astronautics, BuWeps; Maj. Gen. W. B. Keese, Director of Development Planning, U. S. Air Force; Rear Adm. C. B. Martell, Deputy Chief of Naval Operations, Development; and Dr. Richard S. Morse, Director of Research and Development, Office, Secretary of the Army.

Propellants And Explosives Section Steering Committee Meets In New York City

Solid propellants for rockets and guided missiles have introduced new problems

in the fields of safety in production and longevity in storage. The Propellants and Explosives Section, Materials Division, began an investigation of these problems at its steering committee meeting in New York City on January 18th.

Meeting at the call of the chairman, C. H. Madsen, Naugatuck Chemical Division, U. S. Rubber Company, New York City, the committee heard descriptions of the problems received from the Chief of the Army Ordnance Corps.

During the discussion of storage life, Comdr. J. E. Dodgen, Naval Propellant Plant, Indian Head, Md., described the Navy's program over the past five years, which was close to the type of testing being conducted at Picatinny Arsenal, N. J.

An ad hoc committee was appointed to survey the field and to make recommendations based upon the findings of military and industrial experience.

A second ad hoc committee was appointed to investigtae and evaluate both Government and industrial practices in establishing safety design criteria for propellant and explosives manufacture and storage. It is hoped that more realistic criteria will lead to improved safety conditions while reducing acreage requirements and costs.

The steering committee also reviewed its current membership and recruitment policies. It was agreed that members must be of top caliber to assure the reliability of its recommendations. In general, companies would have only one representative in the Section, although alternates might be designated. Broad industry representation and Government consultant assistance were established as basic policy.

The annual meeting of the Propellants and Explosives Section was set for Redstone Arsenal, Huntsville, Ala., on May 22nd and 23rd, but these dates were subsequently changed to June 13th and 14th.

Col. D. V. Macdonald Is Honored At Dinner Meeting Of Panhandle Chapter

The fourth quarterly meeting of the Panhandle Chapter, Mid-Continent Post, featured a social hour and dinner on January 12th to honor Col. Daniel V. Macdonald, Commander, 4128th Strategic Wing, Strategic Air Command, Amarillo Air Force Base, Tex. The affair was held at the Amarillo AFB Officers' Club.

Chapter President M. E. Shaw presided and asked M. C. Kernion to give the invocation. Special guests, in addition to the speaker, were Lieut. Jerry Anderson, area public information officer, Strategic Air Command; and Robert Cairns, Military Affairs Committee, Amarillo Chamber of Commerce.

The A. O. A. preamble was read by Chapter Vice-President B. M. Scott. Other Chapter officers present were: W. D. Forsha, vice-president; R. B. Carroll, vice-president; B. O. Jacobsen, treasurer; and W. R. Rollen, secretary.

Colonel Macdonald's talk revolved around the mission of the Strategic Air Command in deterrence of the enemy. He stated that the Communists are after the whole world and that we are the only obstacle.

In past wars, he said, we have had time to prepare after hostilities started. Now, due to modern weapons, we do not have time to prepare, so we must be ready to deter. The man who has the initiative has a fatal advantage, especially in a war wherein the answer will be decided in a matter of minutes. The Communists are not particularly concerned about sacrificing their civilians so we must be in a position to knock out their military capabilities.

Colonel Macdonald then quoted Gen. Thomas D. White, Chief of Staff, U. S. Air Force, who said, "Military forces which cannot be relied upon to prevail in war cannot be depended upon to provide deterrence." The colonel said that if deterrence fails—and minimum deterrence can—we then must have the strength to win.

Col. D. V. Macdonald, Strategic Air Command, guest speaker, left, and M. E. Shaw, Panhandle Chapter president, during meeting at Amarillo Air Force Base.

This also means, he said, that we should be strong in the field of diplomacy. Hitler miscalculated; he underestimated us by not being aware of our intentions. We should always state our intentions as the Communists have never crossed us when they knew we meant what we said.

Although SAC is trained to get off the ground in fifteen minutes, we need an early-warning system better than we now have. This is why we now keep bombers in the air at all times. SAC bombers also now have a system whereby they can take off at 15-second intervals. The Air Force has felt that the tempo of modern war has advanced so fast there is no time for joint effort for major decision making. All military forces must be centrally oriented and ready to go in advance.

Colonel Macdonald then discussed the various missiles which are now available or on the drawing boards; however, he did not feel that the missile will replace the airplane since the latter, being manned by humans, can withdraw should there be a false alarm. This a missile cannot do —once the button is pressed, it cannot be recalled.

The speaker then discussed some of the new airplanes that are on the drawing boards which will be good deterrent weapons.

He does not feel there will be a nuclear stalemate as we will continue to strive to maintain the balance of power, and the balance of power historically has proved to be a real deterrent. This is something of a stalemate since an aggressor has little advantage if his enemy is equal in power.

Colonel Macdonald went on to say we cannot afford to lose out to the Communists on any front—diplomatically, in the Olympics, Laos, Cuba, or anyplace. They are in total war against us now and we cannot give them the advantage on any front.

He mentioned further that civil defense is another area of deterrence. With an adequate civil-defense plan it is concluded that casualties can be greatly reduced in a surprise attack. We are behind on civil defense and need considerable emphasis in this area. If the Communists know that our civilians are prepared, this will help to deter them.

Colonel Macdonald concluded with the presentation of a color movie on the subject of air weapons and missiles as narrated by Brig. Gen. Jimmy Stewart.

Gen. E. W. Rawlings Holds Meeting of Executive Board Of Logistics Division

Gen. E. W. Rawlings, U.S.A.F. (Ret.), General Mills, Inc., Minneapolis, Minn., chairman of the A.O.A. Logistics Division, conducted a meeting of his Executive

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Association Affairs (Contd.)

Board at Wright-Patterson Air Force Base on January 12-13, 1961.

Association officials attending the meeting as conferees included: Louis Polk, past president; Henry N. Marsh, vice-president for Technical Divisions; and Maj. Gen. Edward P. Mechling, U.S.A.F. (Ret.), staff director for technical operations.

A highlight of the program was a dinner at the Officers' Club on the evening of January 12th. Maj. Gen. Frank Bogart welcomed the visitors to Wright-Patterson and briefly outlined the following day's agenda. General Rawlings and Mr. Polk made brief introductory remarks on behalf of the Association.

General Bogart and Brig. Gen. F. C. Gideon introduced the program on Friday, January 13th, devoted to "Current Management Operations of the AMC." This included a most effective presentation by Col. E. McCloy on "Data Systems Plans of the AMC." Two excellent papers—"Inventory Management System," by Col. J. E. Stiles, and "Support of Selected Weapons," by Col. E. C. Parkerson—concluded the presentations by the Air Matériel Command.

A joint Logistics Division-AMC luncheon was held at the Officers' Club, and the afternoon session was devoted to informal discussion and the business session of the Division.

In addition to General Rawlings, Executive Board members in attendance were: James M. Ewell, Procter & Gamble Company; Brig. Gen. Kenneth Styles, U.S.A.F. (Ret.), General Dynamics Corporation; Jack Schwab, Pennsylvania Railroad; Stanley C. Pace, Thompson Ramo Wooldridge Inc.; R. J. Short, Procter & Gamble Company; and James Summer, General Mills, Inc.

Planning And Programming Committee Reviews Status Of Division Plans

A review of the status of plans of the Association's technical Divisions, Sections, and Committees was made by the Planning and Programming Committee at a meeting in Washington, D. C., on January 26th. Chairman Everett L. Baugh, Cadillac Motor Car Division, GMC, Cleveland Ordnance Plant, Cleveland, Ohio, A.O.A. general chairman for Technical Divisions, conducted the meeting.

Rear Adm. M. F. Schoeffel, U.S.N. (Ret.), General Precision, Inc., Washington, D. C., presented the status of the Missiles and Astronautics Division and reported that appreciable progress is being made on reports to the Army. He also discussed plans for the Division meeting at Point Mugu, headquarters of the Pacific Missile Range.

The report from the Logistics Division by J. M. Ewell, Procter & Gamble Company, Cincinnati, Ohio, noted the disbandment of the Transportation Section because its work program essentially duplicated the efforts of other associations.

Dr. P. H. Burdett, Remington Arms Company, Bridgeport, Conn., reported on plans for a future meeting of the Small Arms and Small Arms Ammunition Division at Fort Bragg, N. C. He noted the importance of preliminary informal planning with possible host agencies to prevent embarrassment to all in case meeting schedules conflict with other plans.

A meeting between the Executive Board of the Underwater Ordnance Division and representatives of the Bureau of Naval Weapons was reported by the Division chairman, Dr. G. R. Tatum, Vitro Laboratories, Silver Spring, Md. He stated that the meeting had been most useful to assure proper orientation of divisional activities and to minimize duplication of effort with other associations.

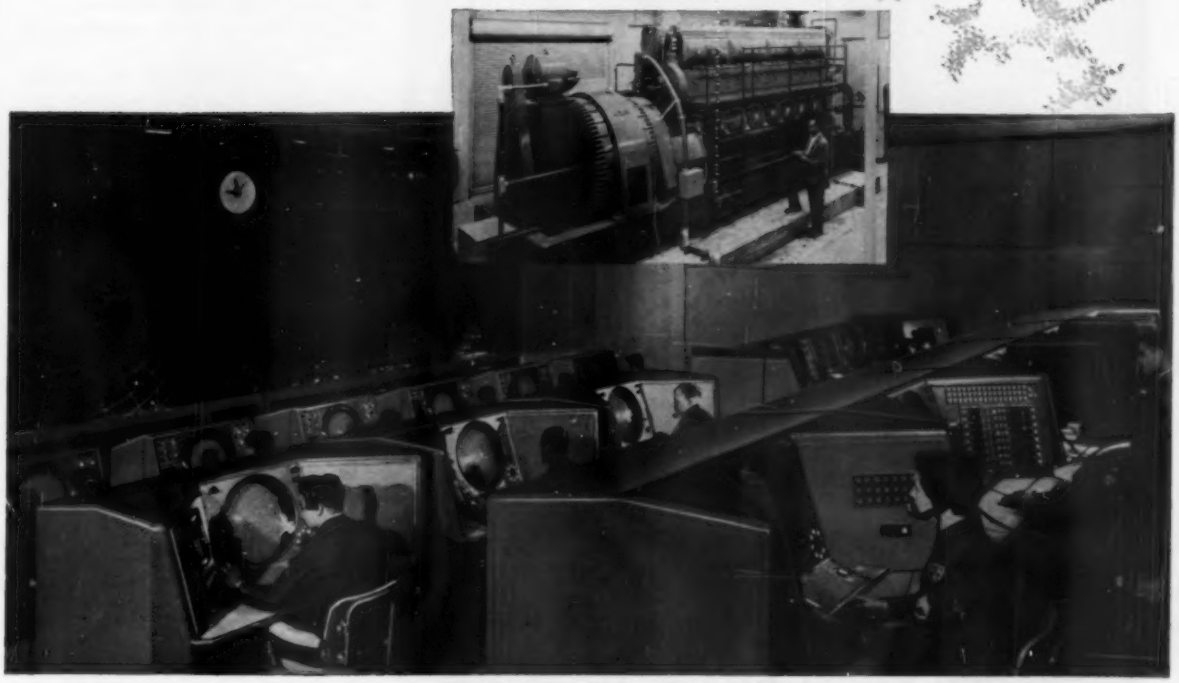
Dr. Tatum also noted that Government limitations on travel funds might so reduce participation by Government consultants that a change in their planned meeting could well become necessary. The meeting was subsequently held on April 12th in Washington, D. C.

Dr. H. A. Nye, Cornell Aeronautical Laboratory, Arlington, Va., reported that Research Division officers had met recently to review the unusual problems faced by the Division because of the nature of its work. The meeting was called primarily to explore methods of optimum productivity and to improve liaison with Government agencies.

F. R. Kadie, Chrysler Corporation, Washington, D. C., reported that travel limitations for Government consultants made it necessary for the Combat & Tactical Vehicle Division to change the meeting scheduled for May 18th.

Maj. Gen. E. P. Mechling, U.S.A.F. (Ret.), staff director for technical operations, reported that the Special Committee on Recoilless Rifles and Ammunition Systems had already begun work with Frankford Arsenal.

WHITE SUPERIOR ENGINES



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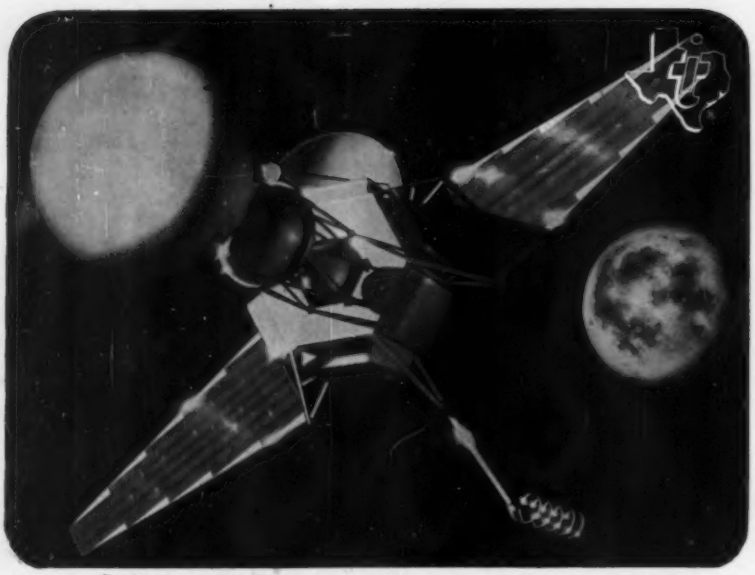

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Association Affairs (Contd.)

W. M. Gourley, Philco Corporation, Philadelphia, Pa., reported that the Special Committee on Value Engineering had been organized, and he invited problems or invitations to speak on value engineering at meetings of the other Technical Divisions and Sections of the Association.

The committee next discussed the statements of capabilities from the Divisions and Sections. A proposed format was discussed and procedures for editing and verifying the final editions were approved. Discussion moved quickly to review a proposed memorandum on funding arrangements for meetings. Brief discussion of the status of membership, the arrangements necessary for meetings, and the policy for issuing invitations to guests at meetings, concluded the agenda.

Empire Post Holds Two-Day Seminar, Annual Dinner, At Buffalo, N. Y.

More than 300 members of the Empire Post heard John R. Blandford, counsel to the House Armed Services Committee, praise the current organization of the Department of Defense as the strongest yet proposed to meet the particular needs of the United States.

Mr. Blandford, speaking at the dinner of the annual meeting of the Post on March 8th in Buffalo, N. Y., reviewed several key factors of our defense requirements which must be considered by our Nation's leaders. He readily accepted contentions among the four services because these controversial positions assure that all viewpoints are presented and considered.

In discussing the supposed simplification which would result from a single service, Mr. Blandford expressed his concern that only narrow, one-sided recomendations would reach the single Chief of Staff and the Secretary of Defense. Thus, the historic policy of civilian control of the military would be negated because it "could result in a captive Secretary of Defense who would be given only that information which his Chief of Staff wanted him to see."

Mr. Blandford also noted that the single-service capability of eliminating competition in production would likewise eliminate competition in thinking. Thus the adoption of a single concept of defense could lead to disaster if that concept were wrong in the tremendous complex of defense problems confronting the United States.

The dinner meeting was the principal event of a 2-day seminar program presented by the Empire Post under the auspices of the Frontier Chapter. John Lally, Wurlitzer Company, Buffalo, N. Y., chairman of the Chapter, was toastmaster for the evening.

On behalf of the national headquarters of the Association, Col. H. C. Thayer, staff director for public information, presented an Association citation to John J. O'Neil, Cornell Aeronautical Laboratory, Inc., Buffalo, for his outstanding contributions to the Association as president and director of the Empire Post and a former chairman of the Frontier Chapter.

Col. J. W. Graham, commanding officer, New York Ordnance District, gave an illustrated talk on "Today's Progress in Ordnance" at luncheon on March 8th. The films and slides emphasized the rapid technological advances in weaponry being accomplished by the Ordnance Corps.

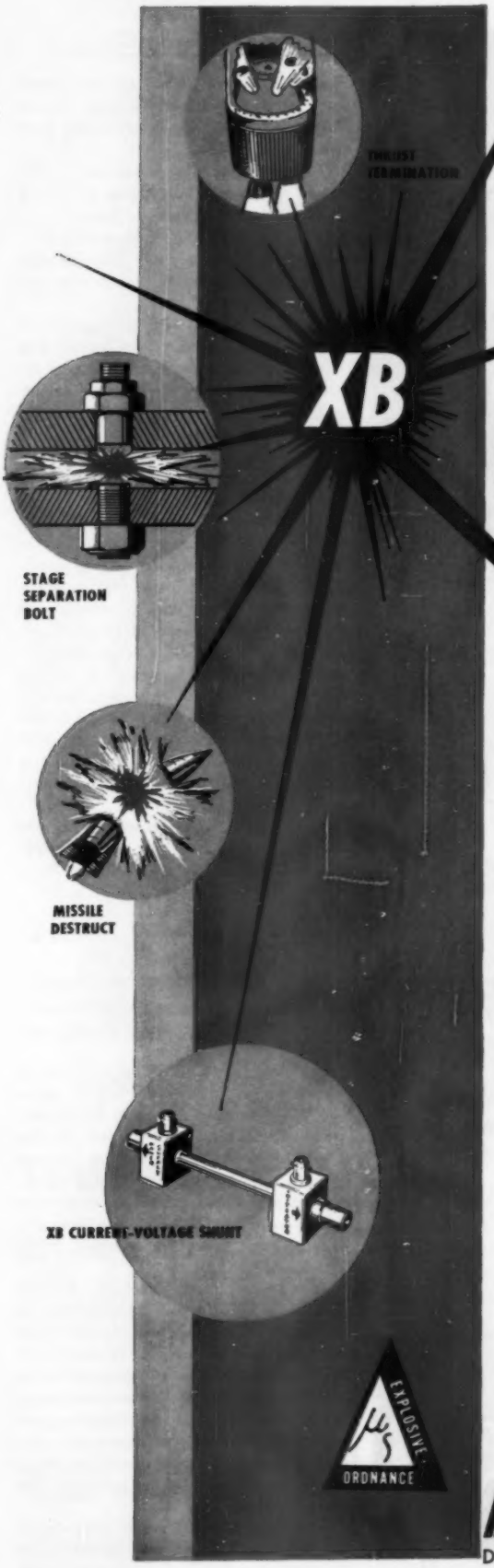
At a luncheon on March 9th, J. Foster Thompson, Thompson & Hayes, Rochester, N. Y., discussed "Problems of Government Contracts—Pitfalls, Safeguards, and Solutions." This luncheon terminated the successful 2-day session at which scores of representatives of large and small business heard expert panelists discuss technical problems and other aspects of the production of defense material.

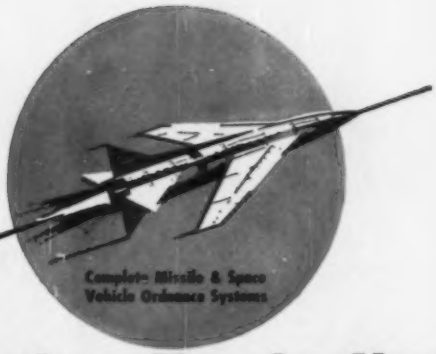
Maj. Gen. J. E. Engler Is Guest Of Honor At Gala Meeting Of Michigan Post

Maj. Gen. Jean E. Engler, Deputy Chief of Staff—Logistics, Continental Army Command, was guest of honor at the gala annual dinner meeting of the Michigan Post on December 1st. The Sheraton-Cadillac's grand ballroom was filled to capacity with members and guests.

The presiding officer, Semon E. Knudsen, a vice-president of General Motors Corporation, called for posting the colors and the invocation delivered by the Post's chaplain, Dr. John A. Visser, minister of Westminster Church.

After Mr. Knudsen's welcome, Post President Arthur W. Wild reported on the year's activities, and Capt. J. M. P. Wright, from national headquarters, presented the Association's certificate of appreciation to two former Post presidents: Del S. Harder (1957) and Mervyn G.





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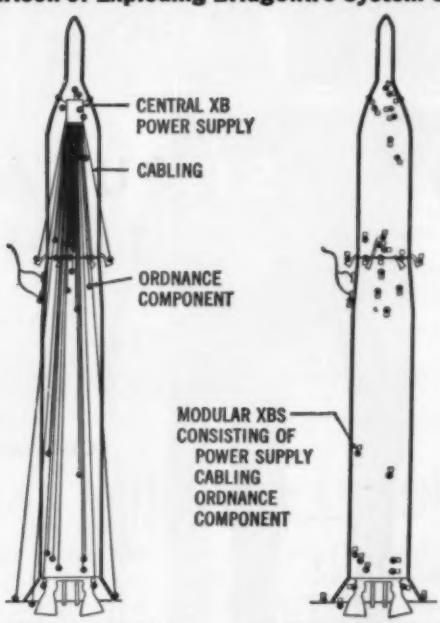
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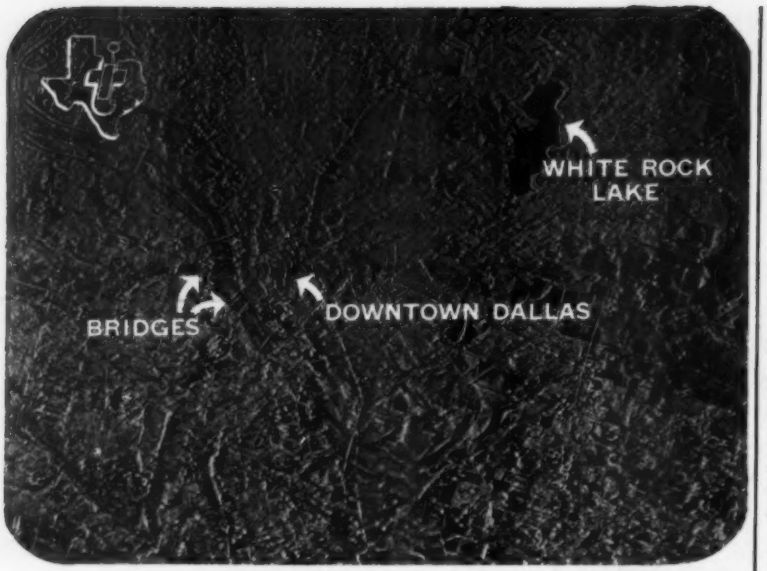

Radar image of Dallas, Texas and vicinity, taken by an all-weather, day or night combat surveillance radar system—developed by TI for the Department of Defense

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Association Affairs (Contd.)

Gaskin (1959). Mr. Wild also announced that Col. H. R. Boyer, General Motors Corporation, had been elected as the Post president for 1961.

General Engler gave a realistic appreciation of logistics by relating it directly to the tasks of the Strategic Army Corps. He said that STRAC was created to give the United States a ready force to stop aggression and also to demonstrate our readiness to act.

We have divisions and battle groups in key positions overseas, he noted, that prove to our allies we intend to resist attacks, but we cannot cover every danger area. Therefore, the three divisions of STRAC (the 82nd and 101st Airborne and the 4th Infantry) with attached support forces are ready to move instantly in any direction into any climate.

The general discussed planning for STRAC that requires preparations to land and attack under the varying conditions he described. He said that the spare parts mounted out with a service unit must match the type of action ordered, with the problem further complicated because the Army's equipment is not all modern and requires excessive maintenance in the field. He noted that the Logistic Command must know exactly what equipment every unit has and its state of readiness so that the correct service support will be ready instantly.

General Engler concluded with the statement, "In spite of the complex problems, STRAC is the most efficient force that the United States has ever had."

Underwater Ordnance Board Meets With Bureau of Naval Weapons To Review Problems

Continuing its objective of assuring optimum relationships with Defense agencies, the Executive Board of the Underwater Ordnance Division met at the Bureau of Naval Weapons on January 11th to consider possible changes to operating procedures and to review current problems. The Division chairman, Dr. G. R. Tatum, Vitro Laboratories, Silver Spring, Md., presided.

It was concluded that basic working arrangements with both BuWeps and the Bureau of Ships were satisfactory; however, the need for stronger recognition of the work of BuShips in sonar and radar fields was recognized. Furthermore, recognition was given to the organizational problems of BuWeps which currently dictate a requirement for quick responses from the Division to the problems they have received.

The importance of contributions made by consultants from field agencies such

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Association Affairs (Contd.)

as the Mine Engineering Facility, Yorktown, was reviewed and their continuing participation was assured. On the other hand, the need for interassociation coordination was pointed out and the Division agreed to attempt such cooperation with other associations to minimize demands on the time of Government personnel.

Members attending included Rear Adm. A. G. Noble, U.S.N. (Ret.), Vitro Corporation of America, Washington, D. C., chairman emeritus; Vice Adm. W. A. Kitts, 3rd, U.S.N. (Ret.), Schenectady, N. Y., deputy chairman; A. D. Anderson, Cook Electric Company, Morton Grove, Ill., chairman, Detection & Control Section; T. E. Lynch, Clevite-Brush Development Company, Cleveland, Ohio, chairman, Underwater Missile Section; F. D. Peltier, Rydal, Pa.; R. W. Robbins, DuKane Corporation, St. Charles, Ill.; J. McW. Stone, DuKane Corporation, chairman, Mine Section; J. C. Kinsey, Vitro Laboratories, secretary.

The Bureau of Naval Weapons was represented by Capts. W. C. Abhau, C. E. Healy, V. P. Healey, and R. C. Smallwood. National headquarters of A.O.A. was represented by Maj. Gen. E. P. Mechling, U.S.A.F. (Ret.), staff director for technical operations.

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• **COL. LUCIAN B. MOODY**, one of the elder statesmen of the Ordnance Corps of the Army and an authority on armament in several of its most important aspects, died on January 27, 1961, at Walter Reed Hospital, Washington, D. C., after a short illness. He was a charter life member of the Ordnance Association, having been one of the earliest members to enroll in 1919.

Born in Huron, S. Dak., he was graduated from the United States Military Academy in 1904. He transferred to the Ordnance Department after meeting the stringent engineering tests of those days, having served a year in the Field Artillery following graduation. He retired from active military service in 1942.

Colonel Moody had several specialties to which his talents were devoted during his long Ordnance service. In the area of automotive equipment he attained prominence in the design and production of tanks, tractors, and trailers. He was similarly identified with the development and production of artillery ammunition, serving at most of the arsenals of the Ordnance Corps, the principal depots, and in the Office of the Chief of Ordnance at Washington.

Prior to his retirement he was in command of the Kingsbury Ordnance Plant, and was requested by the War Manpower Board to assist China in munitions manufacture there. Following the war he was requested by Gen. Chiang Kai-shek to serve as Ordnance Officer on his staff. For this he was twice awarded the Cloud Banner by the Chinese Government.

His decorations from the United States include the Distinguished Service Medal, the Legion of Merit, and the Purple Heart. He was also honored by the French Government.

• **PHILIP B. SHARPE**, a life member of the American Ordnance Association and a well-known writer on arms subjects, died at Emmitsburg, Md., January 24, 1961. During World War II he served for a time as a member of the

Necrology

Historical Section of the Ordnance Department of the Army with the rank of captain. For many years his interest in the Association was widespread.

His first book, published in 1934, was called "This Handloading Game" and was a reprint of a series of articles which appeared in *Outdoors* magazine. Later he became firearms editor of Street and Smith Publications. Subsequently he published two volumes which have been in great demand through several editions. These were "The Complete Guide to Handloading" published in 1937 and "The Rifle in America" in 1938.

Following his service in the Ordnance Historical Section, Captain Sharpe was transferred to Europe in 1944. He became chief of the Small Arms Unit and was assigned to the study of enemy small arms in connection with the Technical Intelligence activities of the American Army in the European theater.

He was a frequent contributor to military and arms publications, serving for a time as a contributing editor of the *American Rifleman*. In 1955 he established Sharpe and Hart Associates, Inc., importers of firearms and ammunition with headquarters in Emmitsburg.

• **PAUL PIGOTT**, a resident of Seattle and a life member of the American Ordnance Association, died at the Mayo Clinic in Rochester, Minn., in January 1961.

Mr. Pigott was active in Association affairs, had served both as an official of the Puget Sound Post and as a national regional vice-president. He had been president of the Pacific Car & Foundry Company since 1934. He was also a director of the Boeing Airplane Company, the Standard Oil Company of California, and the Seattle First National Bank.

A Seattle University regent since 1951, Mr. Pigott was named a knight commander in the Order of the Knights of St. Gregory by Pope Pius XII in 1958 for his active interest in the Seattle University and for his work in the cause of Catholic education.

• **COL. JEFFERSON D. CHILDS,** commanding officer of the Sierra Ordnance Depot, Herlong, Calif., died at the Letterman General Hospital, San Francisco, Calif., December 30, 1960. Well-known in the Ordnance fraternity, Colonel Childs was a native of San Antonio, Tex., and a graduate of the United States Military Academy at West Point in 1932.

Colonel Childs transferred from the Infantry to the Ordnance Department in 1938. After his first ordnance tour at Raritan Arsenal, N. J., he went to the Ordnance Winter Proving Detachment in 1942. A year later, he proceeded to the Mediterranean and European theaters where he served until the end of the war with the 9th Division.

After a tour at Red River Arsenal, Tex., he assumed command of the St. Louis Ordnance District where he served from 1947 until 1952.

Colonel Childs completed the comptrollership course at Syracuse University in 1953 with the degree of master of business administration, prior to a 2-year tour as comptroller at Redstone Arsenal, Ala.

In 1955, he again was assigned overseas, this time as comptroller of the Korean Military Advisory Group. He later was assigned to Aberdeen Proving Ground, Md., and in June 1959 began his final assignment as commander of the Sierra Ordnance Depot.

During his service, Colonel Childs was decorated with the Silver Star and Bronze Star Medals and the French Croix de Guerre with Etoile de Vermeil, the last having been presented by Gen. Charles de Gaulle.

Colonel Childs took a great interest in civic affairs wherever assigned. He first joined the American Ordnance Association in 1941 and participated actively in local meetings.

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ARMY

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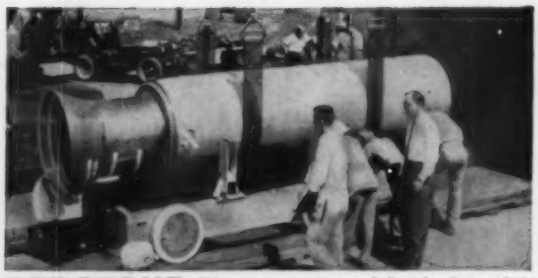
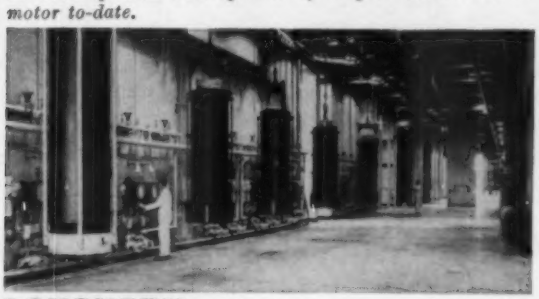
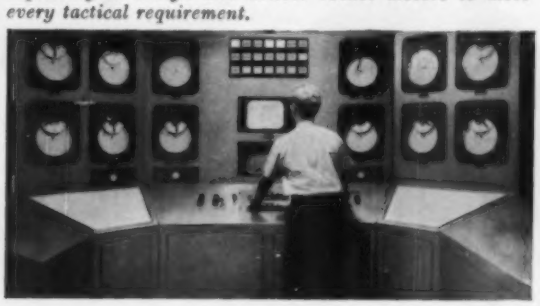


REDSTONE *The most powerful single solid rocket booster ever fired in the free world—450,000 lbs. thrust—was developed for the Army's Nike Zeus program at Thiokol's Redstone Division. The motor is a product of research from propellant formation to scale-up and development of largest thrust rocket motor to-date.*



LONGHORN *Production techniques of the most advanced nature are featured at Longhorn, to assure the military a steady flow of rocket motors of unvarying dependability. Through combined divisional efforts, Thiokol is producing reliable power-plants for the key air defense and anti-missile missiles, the Army's Nikes ... Hercules, now operational and guarding major population centers ... developmental Zeus, whose repeatedly successful R&D launchings underscore Thiokol capability to design and deliver rocket motors to meet every tactical requirement.*



vided by other Thiokol Divisions. Utah, for large engine production — RMD, for sophisticated liquid systems -- Elkton, for diversified special motors.

Experiences gained through their development ... basic laboratory research into high energy fuels and materials, new processing and evaluating methods, automatic production and quality control techniques, the most advanced and fluid research and manufacturing facilities... all have added immeasurably to the progress of Rocketry, U.S.A. All can be brought to bear in the most challenging future projects of the space age.

THIOKOL

THIOKOL CHEMICAL CORPORATION, Bristol, Pennsylvania
Rocket Operations Center: Ogden, Utah

NEW DEVELOPMENTS

Helicopters for the Army

The Army has ordered the first quantity production of the HC-1B Chinook helicopter, a twin-turbine model capable of transporting 33 soldiers at a cruising speed of 130 knots.

The Chinook, with a cargo capacity of three tons, loads through a rear cargo ramp. The ramp may be left partially or completely open or removed for flight. A 30-foot-long cargo compartment with 6½-foot headroom allows for carrying large-size cargoes, such as Pershing missile system components and various sizes of Army vehicles.

Instrumentation is provided for all-weather flight. The 51-foot-long fuselage is 18 feet, 7 inches, at its highest point, with lift provided by two 3-bladed rotors with 59-foot diameters.

The twin turbine engines mounted atop the fuselage deliver 2,200-shaft horsepower each. Range is 100 nautical miles in radius, with a service ceiling of more than 18,900 feet.

Flying Wind Tunnel

A new use for the Navy airship as a "flying wind tunnel" has solved the frustrating problem of testing models of vertical-rising and short-take-off-and-landing aircraft. As part of a long-range study of low-speed flight, it has been established that Navy antisubmarine warfare airships can be converted readily to accomplish cheaply and efficiently what would otherwise require large, expensive wind tunnels. A program for operating the large ZPG-2 airship as a flying wind tunnel is now operating under the joint sponsorship of the Office of Naval Research and the Bureau of Naval Weapons.

Boost-Glide Simulator

An F-100F test aircraft is cutting a scientific swath around the Aeronautical Systems Division so that future aerospace vehicles may someday land on conventional runways. Normally, an F-100F and other present jet aircraft approach a landing flat—almost parallel with the earth—and with power on. Advanced vehicles, with fuel limitations and lacking the lifting power of modern aircraft, will make steeper approaches to land with no power.

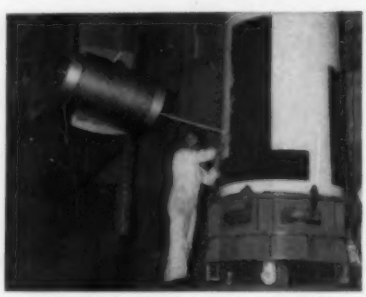
With the alterations made in ASD shops for the Flight and Engineering Test Group, the modified F-100F is able to simulate the landing approach of boost-glide vehicles. What is learned from research with this aircraft may eliminate the need for long runways for landing vehicles like Dyna-Soar and the X-15.

First step in modifying the aircraft at ASD was to remove the afterburner and drag chute and install a thrust reverser. A speed brake three times normal size then was built for the aircraft and variable wing flaps with boundary-layer control were installed.

Other modifications to the F-100F included installation of a landing indicator to give information on height above ground and the speed at which an approach is being made.

X-Ray for Missiles

The world's most powerful linear accelerator for industrial radiographic applications was installed recently in the Quality Evaluation Laboratory X-ray facility at the U. S. Naval Ammunition Depot, Concord, Calif. Shakedown tests have been completed, and the unit is now ready for production operations.



First-stage Polaris missile section is readied for X-ray check (Navy photo).

Two 2-million-volt X-ray units are also employed for examining large rocket sections or engines. The new linear accelerator will reduce the time for examination of these engines and the cost to a fraction of that previously required.

The radiation output from this 10-million-volt unit is equivalent to 70,000 curies of radium, which is approximately 70,000 grams. X-ray pictures or radiographs can be made through six feet of solid propellant or fourteen inches of steel in a matter of minutes and through large-diameter rocket engines in seconds. The "linac" will be employed to X-ray heavy castings and hull sections for Polaris nuclear submarines and for over-all radiography of the large rockets used for Polaris, Minuteman, and Skybolt missiles.

Solid-State Inverter

A laboratory development expected to have important effect upon the application of new sources of electric power was disclosed recently by the General Electric Company which has designed and successfully tested the first working model yet announced of a high-capacity "solid-state" electronic device for converting direct current to alternating current.

It has no moving parts, other than two fans, and it does the work of a 60-horsepower motor-generator set which is almost three times as heavy. With a rating of fifty kva. the new inverter has ten times the power-handling capacity of units of this type announced up to now.

Actual conversion of power from d.c. to a.c. is accomplished by silicon controlled rectifiers which operate instantaneously and require no warm-up. Converting power from d.c. to a.c. by electronic means is a totally different and vastly more difficult procedure than converting from a.c. to d.c.

Nike Conversion Complete

The conversion from guns to missiles for Army National Guard antiaircraft batteries on 24-hour alert as part of the active Army Air Defense Command has been completed. A total of 82 batteries are now on site defending the country's major population areas—76 Nike Ajax batteries in the continental United States and 6 Nike Hercules missile batteries in Hawaii.

The 76 Nike Ajax batteries are now on full-time alert in 14 northeastern, north-central, and West Coast States. They are located in California, Connecticut, Illinois, Maryland, Massachusetts, Michigan, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Washington, Wisconsin, and Virginia.

The Army National Guard now has approximately 15,000 officers and men assigned to air-defense missile units, including 4,200 full-time technicians. The full-time personnel keep the equipment in constant readiness and are capable of firing the missile against attacking aircraft without additional help. The remaining members of the unit are part-time civilian soldiers who would report directly to

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The new, light weight, low cost M-72 infantry weapon is a product of American ingenuity and teamwork. Prime contractor Hesse-Eastern and the team of sub-contractors, pooling their talents and resources and with the close co-operation of the government agencies listed above, have provided an advanced new weapon for America's Arsenal of Defense that is proven and ready to go.

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their missile sites in the event of an alert.

In addition to the 82 batteries on 24-hour alert, the Army National Guard has 45 batteries in an Army training status. The units are elements of missile battalions operating the full-time units and train on the equipment of their combat-ready installations.

New Computer Complex

The first on-line automatic data-acquisition system and computer complex (ADACC) in the United States has been installed at the Naval Propellant Plant, Indian Head, Md., for the purpose of speeding missile research and development. This equipment was specially designed and modified to collect, monitor, and analyze data during the few seconds rocket-motor test firings are in progress as well as to solve scientific and statistical problems associated with rocket-motor development.

The new ADACC apparatus supplies a faster analysis of data from static test firings than was ever before possible. So rapid does the system function that in less than one millisecond (a blink of the human eye is more than 300 milliseconds) after information is generated by the firing it has been recorded, sent to the computer, analyzed, and, if necessary, a signal can be returned to start remedial action in the testing area. Follow-up calculations which once took as many as one hundred man-hours are now completed in less than an hour. Thus performance of fuel mixtures or motors can be evaluated swiftly and improvements initiated before other units come off the production lines.

Radiation Paint

Protection from the heat of nuclear blasts will be given Air Force planes by a simple thing—paint. The special paint, technically identified as a polyurethane coating, developed by the Air Research and Development Command (ARDC), will be sprayed on aircraft to protect them from the tremendous heat generated by a nuclear blast or by firing of the air-to-surface missiles with which they may be armed.

It also will be sprayed on air-to-surface missiles themselves to protect them from possible thermal radiation.

Weightlessness Simulated

Scientists at Chance Vought Corporation have developed a pair of "airborne shoes" and a larger air-supported platform not unlike a floating chair to solve some of the problems of weightlessness a space crewman will encounter. The devices are being used to study man's reactions to his own motions when he has no friction to keep him in place and to develop tools and propulsion and stabilization devices needed in the topsy-turvy environment of space.

Although the "air-bearing" devices by no means duplicate the free-floating conditions of weightlessness, they do permit very free movement on a horizontal plane. Floating on a cushion of air fractions of an inch above a level surface, they demonstrate that the slightest push against a resisting object—or even an abrupt arm movement—is enough to put man in motion and alter his center of gravity.

The platform consists of a square base on which is mounted a space vehicle-type seat. Supporting the platform are three flat circular disks. Air is blown through the disks under a pressure of about eighty pounds per square inch to form a "bearing" between the disks and the flooring surface. The air shoes are similar, except that each is little larger than a skate. Independent movement of the feet permits additional freedom and enhances the "space" effect.

Coherent Light Radar

Development of a "coherent light radar" was announced recently by Hughes Aircraft Company as the initial practical application of the laser, or optical maser,

Light from laser transmitter, top, hits target, reflects back to the telescope.

which the company first developed in July 1960. The new radar, called "Colidar," for coherent light detection and ranging, employs the history-making "coherent light" beam and will provide "the first practical long-range radar for use in outer space." The device has the low-weight, low-power needs and small size required for a satellite in outer space. Essentially the device uses the laser's narrow light beam—instead of microwave signals used by conventional radar—to detect distant targets.

New Missile Heater

A special 150,000-Btu-per-hour heater has been developed by the Army for extensive use in missile systems. The unit is compact, lightweight, and self-supporting, and can withstand rough handling and usage in the field. In comparison with commercial-type heaters, the new device is much smaller and lighter because of its higher operating speed and the high-alloy metals used in the structure.

The heater is independent of outside sources of power, being driven by a standard military engine which develops from 3 to 5.3 horsepower at a constant speed of 3,600 revolutions a minute.

The gasoline engine, electric generator, combustion air blower, air delivery fan, combustion chamber heat exchanger, fuel pumps, electrical instruments, and various other components are all contained in a metal housing 24 inches high, 24 inches wide, and 36 inches long. Weight of the entire package is 300 pounds and is easily carried by four men.

Typhon Weapon System

Westinghouse Electric Corporation is now developing and producing weapon-direction equipment for the Typhon weapon system.

The Typhon is a completely automated missile-firing system for global fleet operation. It is designed to provide the fleet with a defensive system with greatly extended range, accuracy, and target-handling capacity, capable of intercepting and knocking down both enemy aircraft and missiles, and for long-range bombardment of surface targets. The system incorporates a high data rate and high-power features far in excess of present designs. Typhon's reaction time will be measured in seconds.

Mobile Radar Targets

The Federal Aviation Agency and the United States Air Force have announced the introduction of mobile radar bomb scoring (RBS) equipment mounted on railroad cars for use in the Strategic Air Command's "Oil Burner" training operations. "Oil Burner" is the code name for SAC's low-level radar navigation and bombing training operations. It has been in progress since November 1959 to provide SAC aircrews all-weather operational training in new bombing techniques. Operations are carried out against simulated fixed targets over routes approved by FAA at various locations throughout the country.

Strategic Air Command B-47, B-52, and B-58 bombers will make simulated bomb runs on the RBS site. Radar bomb scoring equipment, mounted on a railroad train parked at a railroad siding, will score the accuracy of the theoretical bomb drops made by SAC crews by means of radio and radar signals.

Under SAC's new program, the use of fixed RBS sites will continue. The "RBS Express," designation for the mo-

Rocket motor casing (A) and the fuse-closure section (B) are cold-forged from a special Bridgeport alloy to withstand high full-thrust stresses, yet cut total rocket weight to 2.2 pounds!

New M72 "Tank-Killer" uses super-strength Bridgeport Aluminum Cold Forgings!

This U. S. Army rocket grenade and launcher weighs only a light 4½ pounds that can be slung over any infantryman's shoulder to replace a 20-pound bazooka. Specially designed Bridgeport aluminum cold forgings used for the rocket motor and closure provide a combination of lightness and dependable strength that cuts the rocket missile weight itself to only 2.2 pounds while safely containing the stresses developed by the high energy solid fuel motor. The Bridgeport super alloy has an 85,000 psi minimum tensile strength and an 80,000 minimum yield strength—one of the strongest aluminum alloys commercially available.

Bridgeport worked closely with the prime-contractor, Hesse-Eastern of Everett, Mass., in designing aluminum precision cold forgings to meet exacting dimensional and performance specifications. Machining and assembly costs were cut to a minimum—a vital requirement in this weapon which is as radically low in cost as it is in weight.

The combination of strength, lightness and intricate shape is an excellent advantage of aluminum cold forgings. Bridgeport can tell you how new alloys and improved cold forging techniques can best fit into the design of weapons systems.

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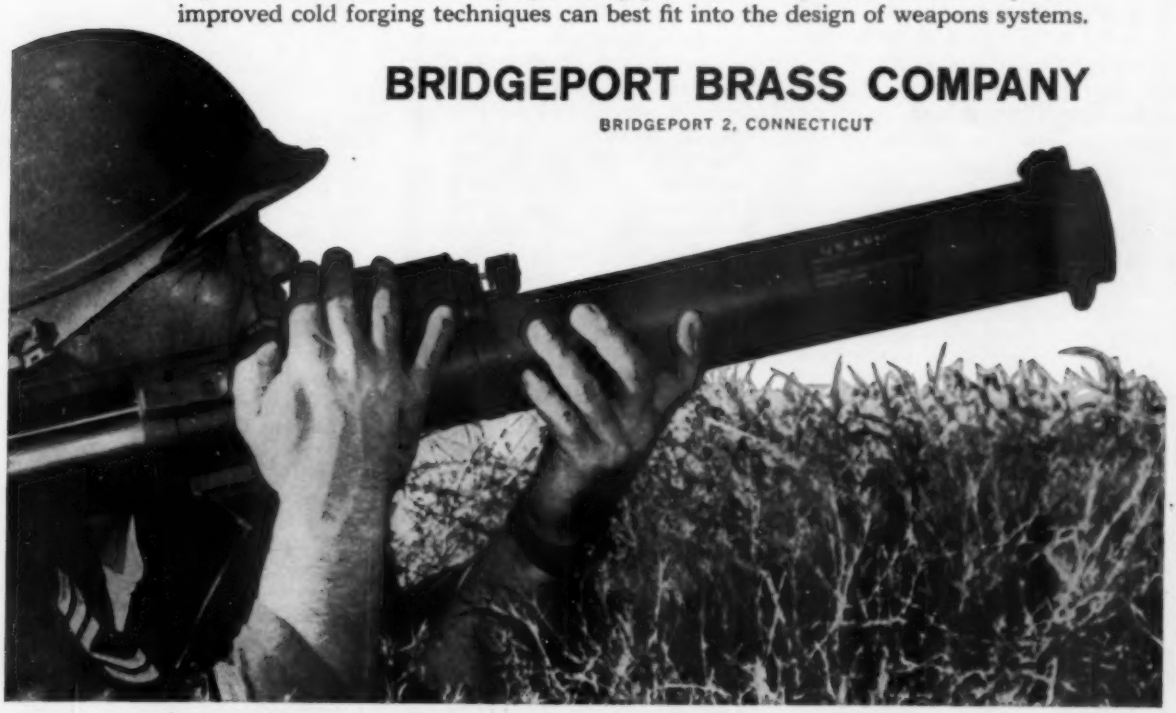


The rocket is carried in its disposable launching tube which also serves as a shipping container. To fire, tube extension is pulled out. Aiming is through pop-up sights.

bile site, is being added to the program to inject more realism into training. SAC jet bomber crews will now be provided a wider range of unfamiliar targets and unfamiliar routes, elements which are now missing under the fixed-target concept. This will be done by moving the RBS site to a new geographical location every forty-five days to simulate new and different target areas. With each relocation, a new "Oil Burner" route, terminating on the "RBS Express" site, will be implemented.

Improved Searchlight

A new military searchlight developed by the Army Engineer Research and Development Laboratories is half the size of the current model but has twice its range and intensity. Trailer-mounted, the new 30-inch general-purpose light will replace the present standard 60-inch truck-mounted unit.

The new searchlight utilizes a very high intensity liquid-cooled carbon-arc mechanism in conjunction with a 30-inch parabolic reflector to produce 450 million peak-beam candlepower with a beam width of 3.25 degrees. It can be operated from the trailer or readily unloaded by two men and operated from the ground. The searchlight is towed by a jeep.

Power for the light is furnished by a lightweight, air-cooled gasoline-engine-driven, 400-cycle a.c. generator, the output of which is rectified to direct current by the use of silicon diodes. The generator also is trailer-mounted and is towed by a ¾-ton 4x4 truck.

Air-Conditioned Suit

An air-conditioned suit that will keep the wearer comfortable in the bitter cold of the Arctic and the extreme heat of the tropics has been developed by the U. S. Navy and Westinghouse Corporation.

The suit was designed for high-heat conditions such as those encountered in ship engine rooms operating under battle conditions with all ventilators closed, but it also can be adapted to meet conditions of extreme cold by pressing a single switch.

The suit itself weighs thirteen pounds, while the thermoelectric unit mounted on the back weighs forty-five pounds, complete with batteries. The only moving parts in the system are two small fans which circulate the air around the wearer. Batteries permit the suit to operate freely for one hour. For longer use, the suit can be plugged into a d.c. electrical outlet.

Heating or cooling of the suit is done by passing a current through thermoelectric couples. The efficiency of the thermoelectric systems is independent of their size, and they can be built in any desired capacity simply by putting together the required number of thermoelectric couples.

Completely airtight, the suit is made of an insulated, aluminum-coated fabric. Air for breathing is supplied through a face mask connected to the side of the suit helmet, where incoming air is heated or cooled by a small heat exchanger.

Hydrostatic Transmission

Hydrostatic transmissions for mobile military applications requiring high torque and nominal ground speeds have been developed by the New York Air Brake Company. Ground-handling equipment, winches, fan drives, and high-pressure hydraulics requirements of off-road Ordnance vehicles fall within the transmission's capabilities.

Compact pump and motor are the heart of the hydrostatic transmission system.

The device consists of a variable-displacement axial piston pump coupled directly to the vehicle's engine and a fixed motor driving directly into the differential or wheels. Hose or tubing replaces driveshafts, universals, gear changers, and clutches. Wheel speed and direction are determined by the pump's variable cam, positioned by a single control lever.

Advantages cited are: (1) Full torque at low engine speeds—even at idle; (2) Infinitely variable, stepless speed ratios; (3) Elimination of wear-prone drive-line components such as clutches, universals, driveshafts, and gear changers; (4) Service brake usage eliminated; (5) Simplicity of operation; (6) Faster yet smoother response to direction changes; (7) Capability to maneuver with two "live" tracks.

The transmission extends the useful range of many vehicles. Soft ground, sand, or rough terrain can be easily negotiated because wheel speed does not increase when static friction is broken.

Satellite Detection Unit

The 1st Aerospace Surveillance and Control Squadron has been established by the Air Defense Command at Colorado Springs, Colo. This new squadron will be manned by the Air Defense Command to serve under the operational control of the North American Air Defense Command and will have the mission of furnishing CINCNORAD detection, identification, and tracking data of man-made objects in space which are of potential or actual military concern.

At the same time, it was announced that unclassified scientific orbital and trajectory information on space vehicles previously published by the National Space Surveillance Control Center, ARDC, Bedford, Mass., would be handled by the NASA Goddard Space Flight Center, Greenbelt, Md.

Locking Compound

The Aeronautical Standards Group has approved a sealant as a means of locking friction-held parts. Made by American Sealants Company of Hartford, Conn., the material is a liquid which turns into a solid when confined between close-fitting metal parts. The new ASG recommendation will be included in airborne electronics specification MIL-E-5400 D and ground-test-equipment specification MIL-T-21200.

The material is a thermosetting anaerobic sealing compound which remains liquid as long as it is exposed to air. Cure is effected by the catalytic action of metal or ceramic surfaces and the exclusion of oxygen.

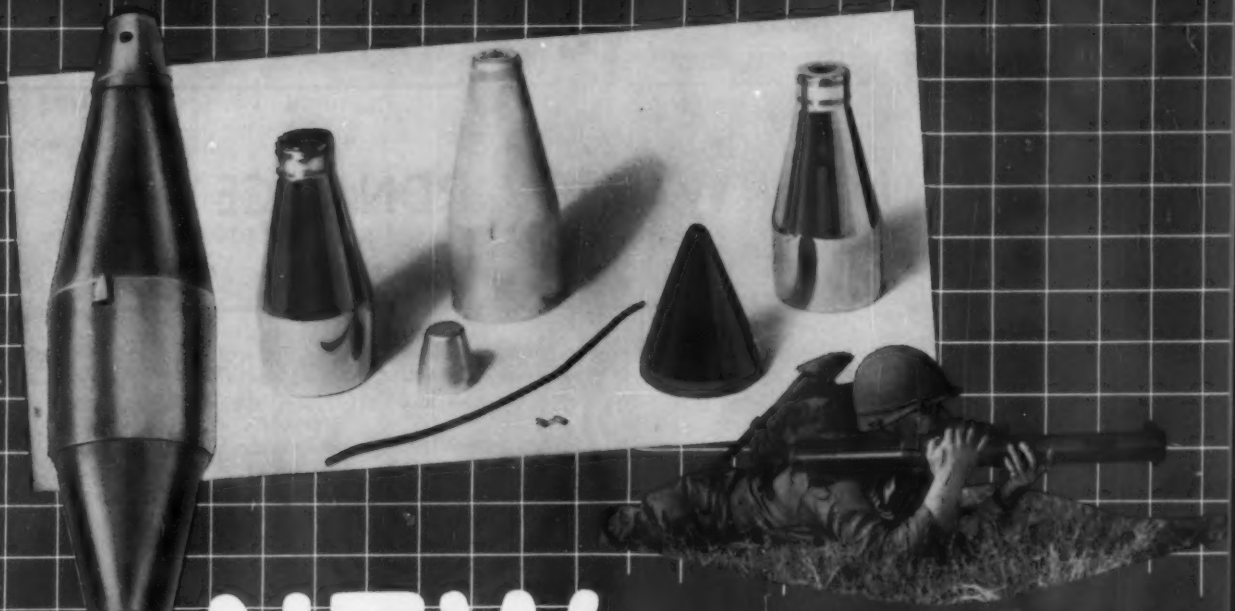
Electronic Safety Techniques

Electronic checkout techniques, similar to those used in missile launchings, are being tested on Army aircraft to determine if the airplanes are safe for flight.

Known as Project Alarm, for automatic light aircraft readiness monitor, the concept envisions the use of strategically placed sensors to forecast electronically the condition of various critical mechanical and structural components, thus saving valuable man-hours in carrying out maintenance inspections on Army airplanes and helicopters.

At the present time, extensive mechanical and visual checks are made on an aircraft before it is considered airworthy. Use of electronic monitoring could reduce the inspection time to a matter of minutes and, in addition, may conceivably remove some of the requirements for special skills on the part of inspection and maintenance personnel. A most important by-product of such a system would be the improved safety factor.

Under the Alarm system, sensors are installed at critical points in the engine, transmission, driveshaft, bearings, propeller or rotor and at selected sites in the structure. These are connected to a central control panel where the pilot or maintenance personnel can literally tell at a glance the status of the aircraft. The system incorporates self-testing circuitry, which makes it virtually foolproof.



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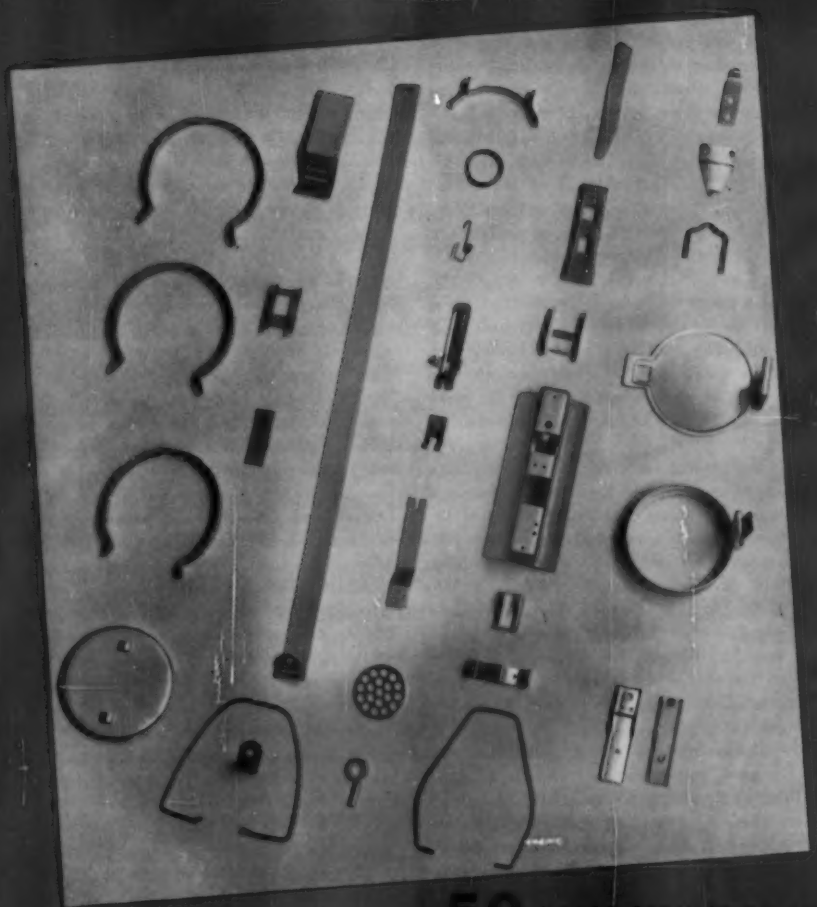
WEAPONS FOR ORDNANCE THROUGH TEAMWORK



- Eastern Tool & Mfg. Co. is proud to be a member of the M-72 team. As a member of this team, Eastern Tool participated in the development and production engineering of this new lightweight weapon for the U.S. Army and is currently producing the metal parts assembly for the warheads, as well as a majority of the metal parts of the launcher and the launcher sling assembly. The illustrations on this page show many of these parts, which we are now supplying and are equipped to deliver on a large volume basis.

- Eastern Tool, well known for the production of ordnance items, assisted in the development and manufactured the first models of the Army's 3.5 inch bazooka rockets, being the largest quantity producer of component parts for the 3.5 inch warhead during the Korean War.

- Since its founding more than a half-century ago, Eastern Tool has been an important supplier of Wire Forms, Metal Stamping and Deep-Drawing to industry.

50 YEARS SERVICE TO INDUSTRY AND ORDNANCE

EASTERN TOOL & MFG. CO. BELLEVILLE 9, NEW JERSEY

WIRE FORMING METAL STAMPING DEEP-DRAWING

UNDERWATER ORDNANCE

Underwater assault transports are under serious consideration by the U. S. Army Transportation Corps. Speed and concealment are major advantages of this concept. No specific hardware programs are currently under way, but the Corps is conducting a number of feasibility studies for underwater transports capable of carrying and landing both troops and logistic supplies.

Concurrent with and a prime requirement of this effort is the need to reduce the current overseas storage factor of eighty cubic feet per ton of supplies.

Development of such transports would carry with it challenging problems in the off-loading of assault matériel. If you've any ideas in this area, contact U. S. Army Transportation Research Command, Fort Eustis, Va.

The depth barrier of coming generations of deep-diving submarines is raising interesting problems of materials and structures, auxiliary machinery, and systems concepts.

Already with the present generation of nuclear submarines, fatigue cracks have been detected in the hulls of some of the older vessels—due presumably to the facts (a) that surface-constructed hulls undergo plastic deformation on their first deep dive with resulting residual stresses, and (b) that modern high-speed submarines do a lot more up-and-down "flying" over a much greater depth (pressure) range than conventional boats.

Another hull material problem arises from the fact that as pressure hulls are required to protect against greater and greater depths they tend to get thicker, and therefore heavier, until the buoyancy limit is reached.

A number of comprehensive research and development programs are under way—including investigation of beryllium, titanium, and aluminum as potential hull materials, as well as efforts to hike the tensile strength of the HY series of hull steels to 250,000 p.s.i. (compared with the present 80,000 p.s.i.).

Some of the problems associated with these efforts: How do you heat-treat a complete welded hull? How do you weld thick high-tensile steel and then control cooling rate so as to prevent residual stresses? How do you accomplish complete homogeneity between weld and parent structure?

Additional research concerns properties and potentials of ultrahigh-purity materials and the properties of metals in the plastic deformation region.

Even with major break-throughs in deep-water pressure-hull materials, the depth will still be reached—Navy scientists feel—when much shipboard auxiliary mechanical and electrical equipment may have to be positioned outside the pressure hull. This will be necessary in order to reduce volume that must be enclosed within the pressure hull, thereby reducing its weight. Such equipment will have to operate in sea water, or at best in oil, under the ambient pressure of the depth of operation.

In this respect efforts are currently under way to design alternating-current electric motors which will operate reliably for long periods of time in high-pressure sea water. As well as providing auxiliary facilities, these may also be used as the main element in the transmission of the main propulsion system.

The problem is (a) one of sealing the main driveshaft from deep-water pressure and (b) increasing the size of the main thrust bearing, as hydrostatic pressure on the end of the shaft increases with depth. The goal here is to eliminate the entire main propulsion shaft and position a repeater electric motor outside the pressure hull which would drive the propeller.

ALUMINAUT will be built.—Final arrangements have been made for the construction and deployment of an 18,000-foot-depth, free-moving, underwater research craft. Reynolds Metals Company will finance construction, and Electric Boat Division, General Dynamics Corporation will build it. It will then be leased to Woods Hole Oceanographic Institute which will operate it under a program financed by the Office of Naval Research.

Recent design changes include: Increased hull thickness from 6 to 16½ inches; decision to construct the hull of 7-foot diameter, 40-inch-long, forged aluminum alloy cylinders instead of 80-inch-long hemicylinders as previously planned; further streamlining of the stern access hatch; replacement of the single swiveling propeller with twin propellers powered by two externally mounted power plants. These will be operated by separate throttles to supply steering capabilities.

Meanwhile, the mesoscaphe—a free-moving research submersible with a depth capability of 36,000 feet—is being built under the direction of Jacques Piccard in Switzerland. This will utilize know-how gained in the construction of the bathyscaph TRIESTE.

Remote manipulator arms built by General Mills' Mechanical Division are being fitted to the TRIESTE to enable objects on the ocean floor to be manipulated and transferred into sample baskets. The present plan is to equip the ALUMINAUT with similar devices.

A small 4-man submarine has been developed for use by the Navy's underwater demolition teams. Battery-powered, it is operated by frogmen who clear away obstacles in the advance of an amphibious assault. The device was demonstrated recently at Navy exercises at St. Thomas in the Virgin Islands.

Details on Lulu, Navy's latest atomic depth charge, have been released. They show that Lulu weighs one-third as much as and is smaller than Betty, which it replaces, and is much more powerful. The air-dropped bird is about 8 feet, 6 inches long and about 18 inches in diameter. Lulu was developed and is being built by General Mills, Inc.

Shock and vibration requirements for submarine-mounted equipment are being stiffened up—and at the same time rationalized. Details aren't available yet, but equipment in the future will have to withstand much more severe combat loads. At the same time, however, specifications and required tests will be more realistic.

Low-cost pressure test facilities for checking out underwater instrumentation have been successfully constructed from surplus 16-inch naval rifle shells by scientists at Massachusetts Institute of Technology and Woods Hole Oceanographic Institute. Pressures up to 20,000 p.s.i. are possible.

Floating launching pads for large spacecraft boosters (such as Saturn) are expected to get feasibility-study money in

The position of Harvey Aluminum in the defense program is unique.

We are a fabricator of metal parts, e.g., the launcher inner tube for the M72 was made as an aluminum impact extrusion.

We are in research and development, e.g., plasma flame deposition for re-entry units.

We are a basic producer of metals, e.g., Zircaloy tubing for nuclear reactors.

the M72

CAPABILITIES, FROM RESEARCH THROUGH PRODUCTION

One demonstration of this uniqueness is the U.S. Army's Davy Crockett. For this tactical weapon, Harvey Aluminum designed and manufactured a prototype titanium gun barrel, designed and developed the prototype integral gun barrel and chamber, designed and developed the lightweight tripod mount, made component ammunition parts, and performed evaluation tests.

The total experience and capabilities of Harvey Aluminum can be applied to any defense assignment, from research through production. Harvey Aluminum, Torrance, California.

the Davy Crockett

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A primary producer of quality aluminum in all alloys and sizes: Pig, ingot, billet, rod and bar, pipe, tube, hollow sections, press forgings, forging stock, hand forgings, impact extrusions, electrical bus bar, rigid conduit, structurals, special shapes, light and heavy press extrusions, screw machine and other aluminum products. Related products in titanium, zirconium and steel.

Underwater Ordnance (Contd.)

fiscal 1962, with funds appropriated for actual conversion of Navy's floating drydocks probably coming in fiscal 1963—according to Vice Adm. J. T. Hayward, Deputy Chief of Naval Operations for Research.

Simultaneously, Polaris submarines are being talked up in the Navy as ideal mobile launching bases for military satellites, antisatellite satellites, and antiballistic-missile missiles. Stressed are the ballistic missile submarines' mobility and security from detection.

Notty, the porpoise, is the star performer of a program now under way at the Naval Ordnance Test Station, China Lake, Calif. What NOTS scientists are trying to find out is the mechanism by which fish (which a porpoise isn't) control boundary-layer flow without cavitation during high-speed swimming and sudden maneuvering. Scientists also want to know how he communicates, echo ranges, and accomplishes such rapid acceleration. Similar studies are being conducted on salmon by the University of Washington.

Nitrogen narcosis tests are being conducted at the Naval Weapons Plant, Washington, D. C., in order to determine the limits of human mental capabilities at great depths. So far, researchers have determined that a reasonably good performance can be expected for a period of 10 minutes at a depth, of 450 feet (200 p.s.i) breathing normal air.

A hydrographic buoy with a signal range of fifteen miles and a battery life of up to thirty hours has been developed by Hastings Raydist, Inc. The system is completely transistorized and was developed for salvage and hydrographic purposes. It employs heterodyne phase comparisons to supply range automatically, while seeker ships or aircraft get a bearing with homing equipment.

A contact analog television piloting system has been successfully demonstrated on board a nuclear submarine. The system provides the submarine's pilot with a direct-vision view as though he were looking through a window in the bow of the ship screened by a grid—thus giving the impression of driving down a highway. When the submarine skipper wants to change course either vertically or horizontally, his orders are presented to the pilot in terms of a shift in the apparent position of the "highway." The helmsman then simply corrects to bring the submarine in line with the center line of the "highway."

White House policy of greater emphasis on conventional weapons for fighting "small wars" should not be overlooked in its potential impact on antisubmarine-warfare spending. Small wars fought with conventional weapons will require conventional logistical supply. Much may be supplied by air but far and away the great bulk will continue to be supplied by ocean surface transportation with all its vulnerability to submarine attack. All the conventional weapons in the world are no good unless they can be delivered in quantity to the site of action.

Lead zirconate-lead titanate piezoelectric elements will be manufactured by Acoustica Associates, Inc., under a license granted by Clevite Corporation.

High-speed underwater shapes will be studied by Boeing Airplane Company in a specially designed boat powered by a J33 turbojet engine. The craft will have twin hulls with a large unobstructed area in between where test shapes will be hung. Boat will feature planing skis to minimize drag and fishtailing and twin rudders which can be spread-eagled as brakes. The 38-foot craft is being built by Blanchard Boat Company of Seattle, Wash.

A smaller, better, high-precision inertial gyro has been developed by Minneapolis-Honeywell Regulator Company for SINS (Submarine Inertial Navigation System)—another step in the current effort to improve the accuracy of the Polaris missile system and to reduce weight and volume of submarineborne equipment.

A major trend in the design of submarine electronics equipment with which every current and potential manufacturer should be familiar is transistorization. This will be the main difference between the current Mark 80 and the upcoming Mark 84 Polaris fire-control system. Space and weight, again, are primary considerations.

The use of surplus torpedoes as mine payloads is a proposal currently under study by the Navy. The idea is that the effective range of nonnuclear mines could thus be extended many thousands of yards. Conventional detection systems now employed in mines would have their range extended and, upon detecting a target, instead of simply blowing up in place would launch homing torpedoes.

This would seem to raise the possibility of the need for an underwater IFF (Identification Friend or Foe—developed in World War II as a coded radar answering device for U. S. aircraft) to prevent such mines from sinking friendly ships.

From Davy Jones' Locker

Problem in Materials: The Navy Bureau of Ships wants a universal rubber-like compound with the resilient properties of neoprene but which is inert to the action of tricresyl phosphate and other hydraulic oils, oxidizers, ketones, and aromatic gasolines. Problems arise from increasing use of flameproof hydraulic oils, exotic fuels, and ketones. The material would be used in shock and vibration mounts.

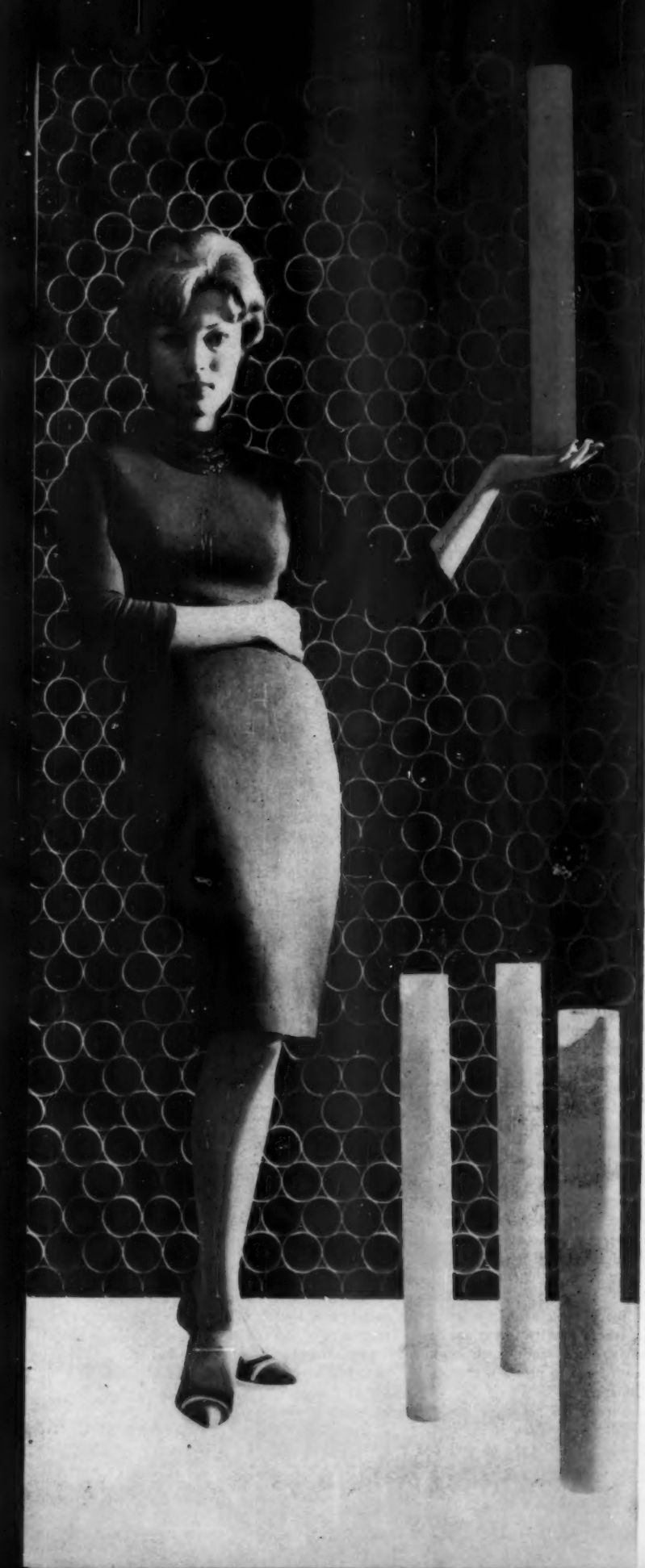
Problem in Resins: BuShips wants an easily regenerative ion-exchange resin capable of removing oxygen from 12,000 gallons of make-up feed water per day while utilizing a maximum resin volume of five cubic feet or less. Need is for treatment of primary coolant water. Complete oxygen removal without any effluent stream contamination is required.

Problem in Torpedo Test: The Bureau of Naval Weapons (BuWeps) needs a rugged, multiple-channel recorder for use within test-fired torpedoes. Requirement is for a 25-channel capability with the data in permanent record form with ready accessibility for automatic processing. Currently these kind of data are taken on film and must be processed photographically. This delay often holds up the next test shot, conditions of which may be contingent upon results of the earlier shot. The system should be capable of oscillographic monitoring.

Problem in Switching: BuWeps is looking for a long-life replacement for the conventional squib and relay. This switching device should be a low-energy system (5,000 ergs maximum) and be capable of at least 100 reliable operations. BuWeps complains that relay reliability in severe environments is poor and that though squibs have a fair reliability (95 per cent) they can only be operated once. BuWeps suggests an entirely new approach to switching techniques.

Problem in Velocity Measurement: The Navy Bureau of Ships seeks an extremely accurate system for measuring the speed of submerged craft with respect to the ocean bottom at speeds of one to two knots. Need is for measurement of ground speed as against speed through the water. Object: Greater navigation accuracy for missile-firing submarines. The problem is complicated by the unpredictable and great range of keel-to-bottom distances. System must be usable anywhere in the world's oceans.

Problem in Power: BuWeps wants a heat-to-electricity power-conversion system with an efficiency of 5,000 watt-hours per pound of device weight. Systems available now have conversion efficiencies on the order of 5 to 10 per cent. BuWeps wants to do better. Object is to find a serviceable method of utilizing surplus heat from main propulsion systems.



11 OUNCES OF LAMTEX *Hystran* SOLVES 1,500 psi PROBLEM

In the development of the U. S. Army's new lightweight M-72 Rocket Grenade Launcher, design and choice of material for its main outer tube received particular emphasis in view of the demanding requirements involved. Because the housing comes into direct contact with the burning rocket-powered grenade, strength was a major factor. For maximum utility as a portable, highly mobile weapon, weight was considered vitally important. To meet both requirements, the Hesse-Eastern Division of Flightex Fabrics, Inc., the weapon system's prime contractor, assigned the problem to Lamtex.

The solution was "Hystran," Lamtex's filament-wound fiberglass reinforced plastic. The result was a main outer housing 2 feet long, with a 2¾ inch diameter and .047 inch wall thickness, **weighing only 11 ounces,** and strong enough to withstand 1,500 psi pressure! And the use of Lamtex's "Hystran" resulted in a significant cost saving, compared to other materials.

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Advancing the state-of-the-art in highest quality reinforced plastics, while serving the needs of industry and the Military.

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INSULATING LINERS
HEAVY DUTY TUBING
CORROSION-PROOF PIPING
HIGH VOLTAGE INSULATORS
UNDERSEA VEHICLES

SPACE ARMAMENT

Nimbus Weather Satellite

The National Aeronautics and Space Administration has selected General Electric Company's Missile and Space Vehicle Department, Philadelphia, Pa., for contract negotiations for construction of the spacecraft and integration of subsystems of the first two Nimbus meteorological satellites.

Nimbus is the second project in NASA's long-range research and development program to explore the problems and technology of a global weather-analysis system. The first extensive meteorological satellite effort, Tiros, yielded more than 35,000 pictures of the earth's clouds and much new radiation data.

The Nimbus spacecraft will differ from Tiros in two aspects. First, it will be oriented so that the television cameras will look down at the earth at all times; and, secondly, it will be launched into a polar orbit, permitting the cameras to photograph the entire globe in each 24-hour period.

A Thor-Agena B vehicle will launch the first Nimbus from the Pacific Missile Range during 1962 into a circular orbit about 600 miles above the earth. The spacecraft, weighing approximately 650 pounds will contain as many as 6 television cameras to photograph the clouds covering the earth. These cameras are improved versions of the models flown in the Tiros satellites. Nimbus also will carry equipment for a number of infrared radiation measurements similar but also superior to those in Tiros II.

Two large paddles of solar cells will convert the sun's energy into electrical power to operate the satellite's instrumentation and supply power to storage batteries.

Cloud-cover pictures and other data stored in the satellite will be played back by command from the primary data-acquisition site at Fairbanks, Alaska.

LOFTI Satellite Results

Before burning up in the atmosphere after a short life of some six weeks, the U. S. Naval Research Laboratory's LOFTI (low-frequency transionospheric) satellite opened a whole new field of scientific investigation that may lead to remarkable advances in military communications and space-vehicle navigation.

By receiving VLF (very low frequency) radio signals from a ground station, the Navy satellite provided science with its first data on the degree of VLF penetration into and through the ionosphere. From the data telemetered back to earth from the satellite, Naval Research Laboratory scientists have been able to confirm their belief that the ionosphere is not nearly as opaque at these frequencies as generally assumed and that VLF radio waves do pass through the ionosphere into the exosphere with relatively little attenuation.

It has thus been definitely demonstrated that while the ionosphere reflects VLF radio waves back to earth to a large degree, it also permits very substantial penetration of VLF waves to outer space.

The information derived from the NRL satellite points, among other uses, to the possible use of transionospheric VLF radio waves emanating from ground stations as navigational aids to manned or unmanned space vehicles and the possibility of communicating with submerged submarines by means of communication satellites.

The data from the satellite also indicates that unlike higher frequency radio waves, which travel through the ionosphere at essentially the speed of light in free space, the velocity of the VLF waves is dependent on the geometry of the signal path and local ionospheric conditions and is a fraction of the speed of light.

Space Engines Studied

NASA is planning to investigate the feasibility of a magnetohydrodynamic (MHD) electric engine which may some day be launched on space missions.

This MHD propulsion engine is a device in which an electrical conducting gas is heated to high temperatures by microwave electrical discharge. The hot gas breaks down into a plasma (small molecular parts—atoms, ions, and electrons) which is accelerated through a flow chamber by a magnetic field and ejected at high velocity from an exhaust nozzle.

An MHD engine has too little thrust to lift a space vehicle off the ground. However, where gravity forces are very small, as in outer space, such engines have enough force to propel a spacecraft to its destination.

Another space engine under study is the thermal arc-jet rocket. It lacks great thrust but has a low rate of fuel consumption which could make a long trip with heavy experiments possible after the mission is boosted into space where the gravity force is very small.

One mission for which the arc-jet engine is now believed capable is to spiral a spacecraft gradually into a "stationary" position above the earth and to maintain it there. It is believed that nuclear electric power also could be used to operate a TV station aboard the spacecraft.

Military Space Policies

The Department of Defense recently announced policies and assignments of responsibilities for development of military space systems covering research, development, test, and engineering of satellites, antisatellites, space probes, and supporting systems for all components of the Department of Defense. These are set forth in a new Department of Defense Directive, No. 5160.32.

Under the new directive, each of the military services is authorized to conduct preliminary research to develop new ways of using space technology to perform its assigned function within limitations to be fixed by the Director of Defense Research and Engineering. When these studies result in proposals for research and development projects, the military services will submit the proposals to the Director of Defense Research and Engineering who will recommend to the Secretary of Defense those proposals which he believes should be developed.

Upon approval of the project by the Secretary of Defense, the management of further research and development of the project will become the responsibility of the Department of the Air Force unless, in the opinion of the Secretary or the Deputy Secretary of Defense, unusual circumstances justify assignment of the particular project to another service. The directive does not affect space research and development assignments previously made.

Radio To Venus

First success in a two-month experiment using radio signals to unveil some of the mysteries of the planet Venus was made known recently by the National Aeronautics and Space Administration when it was announced that clear radio signals had been reflected back to earth from Venus in a 70-million-mile round trip of about 6½ minutes. (*Contd. on p. 834*)

Surefire S/A device for the Army's new "wonder weapon":

another achievement of ZENITH R & D!

Zenith's veteran special products team production-engineered this low-cost, high-reliability safety/arming device in the R&D stage, working with the Systems Development Team —shaved years off the delivery date!

Objective: super-quick, time-integrated S/A device for new 4½ lb. anti-tank weapon. Critical safety/arming characteristics must be maintained despite wide variations in firing conditions.

Solution: give the job to Zenith. Zenith has the broad R&D talent and background in exotic S/A devices, V.T. fuzes—and fuzes for 20mm. rapid fire weapons, rifle grenades, mortars, anti-tank rockets, high velocity anti-tank rounds, high velocity bombs and guided missiles —necessary for assignments like the M-72.

Action: use Zenith R&D capability for your development problems. Send specifications and special requirements to Scott B. Morency, Contracts Division, ZENITH RADIO CORPORATION, 6001 W. Dickens Avenue, Chicago 39, Illinois.

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Illustrated are telescope VPI containers used by Cleveland Rock Drill plant, LeRoi Division, Westinghouse Air Brake Co., with spare parts they protect.

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The answer may be Cleveland Containers with liners treated with VPI ... Vapor Phase Inhibitor ... which are both economical and highly effective against corrosion.

Use of VPI containers also have three *extra* money-saving advantages:

1. **Eliminate the need of heavy protective oils or greases.**
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Constructed of quality fibreboard with metal ends, the 2-piece containers, shown above, are made in a wide range of diameters and lengths to "fit" a specific part or product. VPI containers can be labeled with preprinted wrappers, direct printing, or plain color wraps.

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Space Armament (Contd.)

The transmission was accomplished at the Jet Propulsion Laboratory Goldstone Tracking Station, fifty miles north of Barstow, Calif., in the Mojave Desert.

Other experiments have bounced signals off Venus, but this is the first time such signals have been immediately detectable without elaborate analysis and processing.

The objectives of the two-month experiment are to: Determine whether Venus spins on its axis and the rotation speed; determine the orientation of the planet's spin axis; investigate the nature of the surface of Venus as determined by its reflectivity; and further define the measuring stick of the universe, the approximate 93-million-mile astronomical unit. The exact length of the unit, the mean distance from the earth to the sun, has not been defined to within about 10,000 miles.

Satellite Ground Stations

A cooperative program for the transatlantic testing of experimental communication satellites provided and launched by the National Aeronautics and Space Administration has been announced jointly by agencies of the United States, England, and France.

The British General Post Office and the French Center for Telecommunications Studies have agreed to provide ground stations in Europe for transmission of multichannel telephone, telegraph, and television signals using satellites to be launched by NASA during 1962 and 1963 in Projects Relay and Rebound.

The stations will be equipped with advanced radio facilities having extremely accurate tracking and antenna-pointing qualities and capable of conducting tests with active and passive satellites at high frequencies and low power. Surveys currently are being made to determine their locations.

Project Relay, NASA's low-altitude active repeater satellite programmed to be launched in 1962, will weigh less than 100 pounds. The spacecraft will contain instruments to detect radiation damage and other environmental effects on critical components as well as communication experiments.

Project Rebound is a follow-on of NASA's first passive reflector communication satellite program, Echo. It proposes to place several rigidized inflated spheres in orbit by using a single launch vehicle. The first launch to orbit three spheres is programmed during 1963.

Relay and Rebound are research and development projects to demonstrate the feasibility of basic concepts and technological approaches and to evaluate various systems to be employed in communications satellites.

MATERIALS PROGRESS

George S. Brady

New Copper Process.—Construction of a new plant to produce 99.95-per cent pure copper directly from ores entirely by chemical processing, without the conventional smelting and refining, accents a revolution in metallurgy that has been going on for more than a decade and is now coming to commercial fruition with the old-line common metals.

Except in refinements, bettering of processes, and introduction of new equipment, metallurgy, or the art of separating metals from their ores, has not, until recently, changed in format in centuries. As often occurs with revolutionary changes, the new all-chemical methods have not been originating with the old established industry, but have been introduced largely by "outsiders."

The work being done on the old-line metals is really the outgrowth of research done on the newer rare metals, accomplished largely by the chemical industry and its equipment manufacturers.

The new copper plant is being erected in the Philippines, but the entire design and development is in the hands of two American companies, *Foster Wheeler Corporation* and *E. W. Bliss Company*. The ore to be used at first will be high-grade, but all-chemical processing lends itself to the utilization of extremely low-content ores. For example, the New Mexico ore employed by the *Phillips Petroleum Company* to obtain uranium averages only 0.24 per cent uranium oxide.

The only old operation retained in the new plant is the concentration of the ore by conventional crushing and flotation, which is really a preplant mining operation. Some partially chemical processes have been used by the metallurgical industry. As an illustration, the *Kennecott Copper Corporation*, in extracting molybdenum from its ore, uses chemicals to produce soluble sulphates and then uses ion exchange and solvent extraction to get the oxide and finally the metal. But it first uses metallurgical roasting of the ore concentrate to remove the sulphur.

Colonel Brady is a consulting engineer, author, and editor, Washington, D. C. He is a well-known authority in the field of materials, and his "Materials Handbook" is a recognized source of information on the subject.

All-chemical ore processing is yet in its infancy, and costs for very low grade ores are still high. But all-chemical extraction offers big attractions for the future. It is said that a chemist "can extract anything from anything," and thus—since most common-metal ores also contain small quantities of other metals, sometimes as many as a dozen other metals—the chemical process can extract all the residual metals.

Chemical processing is economical in labor, and it is easier to control quality. Once a process has been worked out by research, the plant consists of a series of closed tanks, vessels, and piping through which the ore moves in solution, and the labor requirements consist largely in watching gauges and making adjustments.

Finally, chemical plants usually can be made in smaller economical units, thus making it possible in the future to utilize profitably the vast number of small ore deposits that occur in various parts of the country. These deposits often have very rich ores but in such small quantities that it is not profitable to develop them by metallurgical methods.

But the big, large-scale producers have been active in technology. For some time, *Alcoa* has been extracting the thallium metal which occurs in minute amounts in the aluminum ore. *Aluminium, Ltd.*, is erecting a plant at Arvida, Quebec, to produce alumnium metal directly from bauxite by a continuous chemical method.

International Nickel Company is building a plant in Ontario to reclaim from the pyrrhotite nickel ore the iron which has heretofore been a nuisance. After removing the nickel and the sulphur, the residue is reduced to a magnetite powder and made into pellets which are admirably adapted for steel production. A short ton of ore yields 1,500 pounds of 68 per cent iron pellets.

In the copper industry, concentrating methods have been improved, and calcining has been adopted in order to use limey ores. Oxygen is now being used in roasting and smelting. Poling is being superseded by the employment of a gas stream. At *Kennecott*'s Utah Copper Division plant, the preroasting process is being converted to direct smelting. Metallurgical processing is likely to remain into the indefinite future as the most economical method for large-scale operation.

But one example will illustrate how the large metallurgical operators are diversifying, and especially developing the residual rarer metals in the ores. *Chase Brass & Copper Company* has now established a Rhenium Division, after developing the manufacture of rhenium rod, wire, and strip for more than a year.

The rhenium metal comes from the parent company, *Kennecott Copper Corporation*, as a by-product of the roasting of molybdenum ore, and is obtained as a dense, silvery powder which Chase works into wrought forms. Rhenium metal has a high melting point, 5,756 degrees Fahrenheit, with good electrical and mechanical properties. Thermocouples of rhenium versus tungsten are used for temperature measurements and control up to 2,800 degrees centigrade. Rhenium electrical contacts give very long service life.

Thermoelectric Materials.—The Atomic Energy Commission is searching for efficient thermoelectric converters of small size and low weight. A 5-watt converter operating with strontium will weigh about half a ton, but an AEC research contract with *Royal Research Corporation* and *Westinghouse*, using cesium 137, gives promise of a unit that will deliver the same energy with a unit weight of not more than 300 pounds, in a space of about 1 cubic foot, and be able to operate continuously for 10 years. The compact units are wanted for remote military and weather stations.

Size and Weight Reduction.—By the use of tantalum, *Radio Corporation of America* has been able to reduce drastically the size and weight of capacitors, as compared with those made with other metals. In this connection it is useful to note that the old cliché, "War is waste," is not true for our defense research program, since the results of the materials and components research are used immediately to improve commercial civilian products which could otherwise not afford the research and development expense for so rapid an advance in technology.

The nuclear cartridge for nuclear-powered turbojet aircraft, built by the *General Electric Company* under Air Force and AEC development contracts, is reported to weigh only thirteen pounds and is expected to replace heavy loads of jet fuel. It contains 19 fuel elements composed of 150 cartridges of 93 per cent uranium dioxide in a matrix of nickel-chromium alloy, encased in a beryllium

Materials Progress (Contd.)

reflector. Hydrated zirconium is the moderator. The high heat of the uranium fission causes the surrounding air to expand and rush out of the engine to add thrust to the plane.

Signaling Material.—A new photoemission coating material that can be used for operating temperatures above 140 degrees Fahrenheit has been developed by the *Westinghouse Electric Corporation* under a research and development contract with the Navy Bureau of Ships for signaling equipment. The coating is a compound of antimony, potassium, and sodium, and the thin films on glass are transparent. The radiant energy of light striking the coating is converted into electrical energy by the release of electrons. Previous coatings used have tended to have low operating life and to be destroyed by elevated temperatures.

Low-Temperature Coating.—The *National Bureau of Standards* has developed a new type of ceramic coating that can be bonded to metals at relatively low temperatures—400 degrees Fahrenheit. The process consists in using a monoaluminum phosphate as the bonding agent for the ceramic oxides. Very thin coatings give protection and have good thermal shock resistance. Conventional ceramic coatings for low-temperature application usually contain high proportions of lead, making them undesirable for many uses.

For mechanical parts subject to extremes of wear erosion, such as in ore-handling equipment, or to extremes of chemical erosion, such as processing equipment operating with corrosive chemicals at high temperatures, the *Carborundum Company*'s research engineers have been pointing out that pressed, cast, or extruded parts of the new impermeable silicon carbide can replace costly high alloys, and in their research, they have been subjecting the silicon-carbide parts to "punishing" comparative tests.

The formed parts are given a high-temperature treatment to produce the dense, self-bonding structure, and the rough crystalline surface is smoothed by abrasive polishing. The extremely hard "KT silicon carbide" has increased the life of sleeve tubes for ore crushers as much as 2,000 per cent, compared with those made with high alloys.

The material is resistant to oxidation in air at 1,000 degrees centigrade, and gives good resistance to wet chlorine at 600 degrees centigrade and to fused sodium chloride salt at 900 degrees centigrade. It has been successfully tested for a missile nose cone at a temperature of 1,900 degrees centigrade.

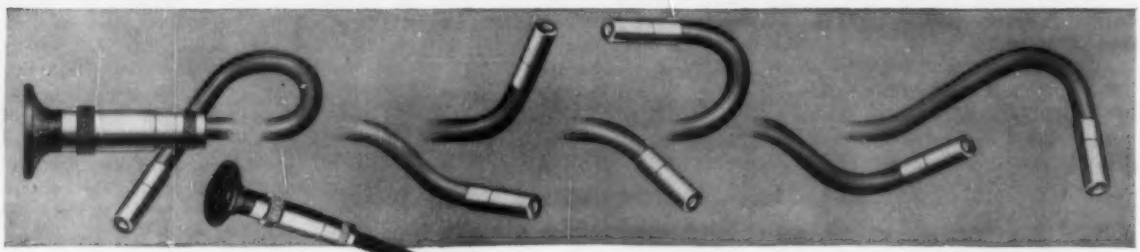
Titanium Usage.—Eighty-five per cent of the 10 million pounds of titanium metal produced last year went into military uses, and about 13 per cent of the total was used in commercial aircraft, according to figures compiled by the *Titanium Corporation of America*. The remaining 2 per cent went chiefly into chemical equipment.

Although the price of the wrought metal and alloys has dropped 40 per cent in the past 5 years to an average of slightly less than $7 a pound, cost still appears to be the ruling factor preventing its use in consumer products.

Titanium Corporation has a new process, called Impel casting, which produces titanium castings at about half the previous casting costs if ordered in lots sufficiently large to pay for the mold, say twenty-five. The mild-steel molds used will last for one hundred castings. Regular casting is usually in one-shot graphite molds.

New Chromium Plate.—*The Alloy Surfaces Company*, Wilmington, Del., has a new diffusion process for chromium-coating steel to give a controlled amount of chromium on the surface as a true adherent alloy and not a plate. The process is called Alphatizing. Low-carbon steels are capable of receiving the greatest

(*Continued on p. 840*)



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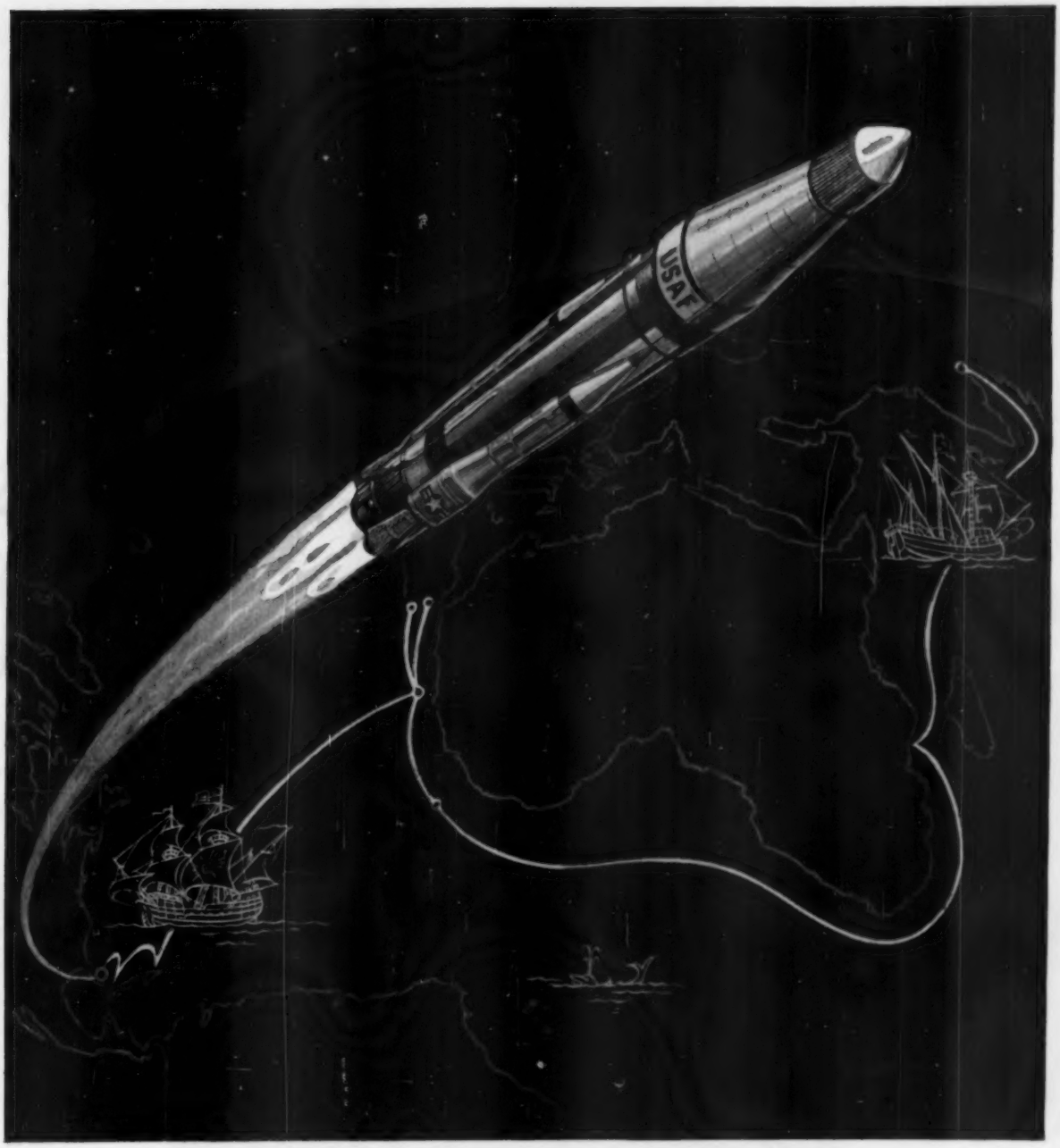

Arma navigates new routes

Navigating with cross-staff and primitive compass, Prince Henry's Portuguese pilots took more than 80 years to find a route around Africa and reach India. The Spaniards took another 20 years to cross the Atlantic and reach the shores of Florida.

Today, missile-borne inertial guidance can navigate such distances in a matter of minutes and pin-point targets nearly half-way around the world. Other advantages of inertial navigation are immunity to outside interference, all-weather capability, salvo firing, and a minimum of ground equipment.

Arma, designer of America's first inertial guidance of intercontinental range accuracy, has these systems in full production with on-schedule deliveries. Although specified for the Atlas missile, the Arma system is equally adaptable to other aerospace programs and space exploration projects.

At Arma, research programs currently are exploring smaller, supersensitive devices for future generations of missile and space guidance systems. Arma, a division of American Bosch Arma Corporation, Garden City, New York. . . . The future is our business.

8331

AMERICAN BOSCH ARMA CORPORATION

Airborne crane built 500 pounds lighter with USS TRI-TEN High-Strength Low-Alloy Steel

This air transportable, air droppable U. S. Army crane had to be strong enough to lift 7 tons but light enough to be parachuted into a combat area. The Koehring Company of Milwaukee, Wisconsin, solved the problem with USS TRI-TEN High-Strength Low-Alloy Steel. ☐ By using USS TRI-TEN Steel in the turntable, the lower works of the cruiser, and the boom, Koehring designers used only two tons of steel . . . with a clear saving of 500 pounds. Strength was not sacrificed because USS TRI-TEN Steel has a minimum yield point of 50,000 psi. ☐ USS TRI-TEN Steel is well known as one of the most weldable and toughest high-strength low-alloy steels in the industry. Its superior notch toughness at low temperature makes it ideal for all-weather mobile equipment. TRI-TEN Steel has excellent weldability, good resistance to abrasion, and atmospheric-corrosion resistance that is about double that of structural carbon steel. ☐ For other military vehicles, United States Steel makes extremely tough, rolled alloy armor plate, in addition to a complete line of high strength steels, "T-1" Constructional Alloy Steel, Stainless Steels and carbon steels. For more information, write United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

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USS United States Steel

Lightweight crane built strong with USS TRI-TEN High-Strength Low-Alloy Steel. Designed for the U. S. Army Corps of Engineers, Ft. Belvoir, Va. Builder: Koehring Co., Milwaukee, Wis.

This mark tells you a product is made of modern, dependable Steel.

Certain vessels are **supposed** to crack under internal pressure. If you'd like to know more about them, ask a poultry man. But, if you're more interested in vessels that **won't** crack under pressure, ask National Tube. We make high pressure seamless vessels with up to 3-inch thick walls to contain pressures as high as 10,000 psi at temperatures ranging from minus 320 F. to 1,000 F. USS National Seamless Steel Cylinders are perfect for handling, transporting or storing gases or liquids. They're pierced from solid, white-hot billets of high-quality steel—carbon, alloy or stainless. Write for Bulletin 25. National Tube Division, United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

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Materials Progress (Contd.)

chromium-alloy penetration, while the high-carbon steels give less penetration but greater hardness of the coating.

Synthetic Ruby Maser.—*Hughes Aircraft Company* has a new ruby maser, called Colidar, to transmit beams of coherent, or narrow monochromatic, light, for use as a range finder to measure the distance to a distant object. The distance is shown by the time required for the light to travel to the object, be reflected, and return. Much research work is being done by various companies on materials for masers.

For radio application it is stated that a mixture of helium and neon gases in a tube requires less power input than a solid-crystal maser and generates a coherent infrared light beam that can carry many times the amount of information that can be impressed on a radio wave.

Synthetic ruby, which is an aluminum oxide, gives in a maser a pulsed beam of infrared light. Calcium fluoride with 0.1 per cent of the calcium ions replaced by trivalent uranium ions, gives a continuous wave of infrared of 2.5 microns, toward the Hertzian or radio wave band, while calcium fluoride with divalent samarium ions to replace a small part of the calcium gives a continuous red light of 0.708-micron wave length toward the end of the visible light band.

Light of all colors travels with the same speed, and the object appears to be, at least for information carrying, to seek out the best possible maser materials for use within the lower wave lengths of the usable part of the infrared light band.

High-Strength Carbon Steel.—A group of mild steels of such high strength that they are claimed to give savings up to thirty-five per cent in the weight of structures, compared with ordinary carbon steels, is the GLX-W steels of the *Great Lakes Steel Corporation*, Detroit, Mich. They are refined carbon steels containing a small amount, 0.01 to 0.04 per cent, of columbium. A typical analysis is: carbon, 0.16 per cent; silicon, 0.05; manganese, 0.68; sulphur, 0.018; phosphorus, 0.009.

The added columbium gives a fine grain, the fineness increasing with increased columbium. The columbium also improves forming and welding properties, besides increasing yield strength. The GLX-55 grade has a tensile strength of 75,000 pounds per square inch, yield strength of 58,000 pounds, and elongation of 27 per cent.

Graphite for Bearings.—The Engineering and Research Department of the *Ford Motor Company* at Dearborn, Mich., has developed an iron-bonded graphite for dry bearings that gives higher strengths than are possible with graphite alone, and still retains the antifriction properties of the graphite. The parts are made by powder metallurgy, with a content of 40 to 90 per cent graphite. The balance is a mixture of iron powder and a calcium-silicon powder. The calcium-silicon alloy overcomes the normal low compatibility of the iron and graphite and results in a stronger, less brittle material.

Moderate-Cost Steel.—A typical example of the new moderate-cost, high-strength steels, made without any considerable use of the scarcer and more expensive "strategic" metals, for use in tools and special forgings, is the Lo-Air steel of the *Universal Cyclops Steel Corporation*, Bridgeville, Pa.

This steel is air-hardened from a relatively low temperature, 1,550 degrees Fahrenheit, giving deep and uniform hardness without deformation. It will harden to about Rockwell C62, and when tempered to Rockwell C58 has a tensile strength of 300,000 pounds per square inch with elongation of 1 per cent. When annealed, it machines easily. It contains 2 per cent manganese, 1.35 molybdenum, 1 chromium, 0.30 silicon, and 0.70 carbon. The "secret" of the new steels is in the careful balance of all ingredients to make full and complete use of their various intermetallic characteristics.

The Magnetic Surfacing Pilot Production Area; Mr. H. B. Dickinson, Vice President (left), and Mr. B. Diener (center) and Dr. M. B. Melillo (right) of the Component Development Division.

A Report from American Systems Incorporated...

A New Development in Magnetic Surfacing

In improving the performance and economy of many computing and data handling systems, the surfacing of magnetic memory drums, disks, rods, and tapes tends to be a limiting consideration. Now at American Systems Incorporated, an important new process for surfacing these components is in the pilot production stage. Based on a completely chemical (catalytic) principle, the American Systems process provides magnetic surfaces of greater metallurgical hardness and uniformity than conventional electroplating or spraying. Packing densities are also greater, and higher recording frequencies may be used. Further, the deposition may be controlled so that coercivity and remanence of the surface meet specific application requirements. In the pilot facility, a wide range of component sizes and shapes can be handled simply and rapidly.

Developed by Dr. Manlio Melillo of American Systems Component Development Division, the new process typifies the systems approach to component problems. In addition to magnetic surfacing, the activities of this division encompass component development for computer and communications systems technology.

Front-line technical efforts are also under way at American Systems in six other Divisions:

INFORMATION SCIENCES

Mathematical and statistical research; computer programming, and advanced programming systems; computation services; digital system studies; logical design; advanced systems analysis.

COMMAND AND CONTROL SYSTEMS

Logic of command and control complexes; systems design and development; data acquisition, processing and display; communications.

ELECTROMAGNETIC SYSTEMS

Electromagnetic physics; electronic and mechanical scanning antenna systems; development and manufacturing of special microwave components and complete sensor systems.

RESEARCH LABORATORIES

Solid state physics and systems; magnetic thin-film research and subsystems; advanced components for information processing.

INSTRUMENTS

Research and development in analytical instruments; detection and monitoring of toxic high-energy missile fuel vapors; gas leak and water vapor detection; on-stream and process control instrumentation.

AUDIO-VISUAL

Audio-visual (Instructron) devices for instructional and assembly line applications; production of work stations designed on human factors principles.

These programs are being conducted by an outstanding staff of scientific and technical personnel, over half of whom have advanced degrees. Custom facilities for this work are located in a 27,000-square-foot plant. The first unit in a long range building program, this plant is situated on a 13-acre site.

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ARMAMENT ELECTRONICS

Traver B. Van Vliet

Moon Photographic System.—National Aeronautics and Space Administration's Jet Propulsion Laboratory will soon award a developmental contract for a photographic system to be used for mapping the moon from a projected lunar orbiting vehicle. If funds permit, the system will be launched by an Atlas-Centaur in 1964.

Aircraft Display.—A vertical tape display instrument, which displays vertical height and vertical speed, will undergo testing at Wright Air Development Division. The tests are part of a program on all-weather landing being conducted jointly by WADD and the Federal Aviation Agency. The indicator was developed by the Instrument Division of Lear, Inc.

Airtrac.—The Nation's first helicopter-borne electronic air defense control system has been delivered to the United States Marine Corps by Hughes Aircraft Company. It is the first of four "Airtrac" systems developed and manufactured for the Corps. The system will coordinate firing of Hawk and Terrier guided-missile batteries to ensure nearly instant destruction of hostile supersonic aircraft.

Airtrac is installed and transported in helihuts, 3,500-pound plastic and aluminum boxes approximately the size of the rear section of a 2½-ton truck. The helihuts are carried underneath Marine helicopters, and the system is operational within minutes anywhere helicopters can land it.

Starfighter Inertial Navigation.—Inertial navigation systems for the Lockheed F-104 Starfighter have been produced for the Canadian Government by Litton Systems, Inc. These are believed to be the first production systems to be employed in operational fighter aircraft and are capable of providing navigation data to guide the aircraft to up to fifty preprogrammed targets without reliance on external navigation aids. Flight tests of the LN-3 system are being conducted by Lockheed and Litton and are expected to continue until late this year. Orders from the Canadian Government and Lockheed call for the production of 400 of the units.

Orbital Antenna.—The National Aeronautics and Space Administration has awarded a contract to G. T. Schjeldahl Company for the design and production of 135-foot, 500-pound inflatable spheres for its passive communications satellite program. First test launch of the sphere is scheduled for next year. The sphere will be put into a 1,000-mile orbit by a Thor Agena B vehicle.

Digikey.—Development of a push-button communications device that enables a jet pilot to communicate with his base with greater speed and accuracy has been disclosed by Hughes Aircraft Company. Called "Digikey," the device permits a pilot or crewman to "talk" through heavy electrical interference at a rate of 150 words a minute by punching keys on a small semiautomatic keyboard. Digikey was recently installed in a Strategic Air Command aircraft and subjected to a weeklong airborne evaluation by SAC officers and technicians.

The device converts a message into digital form and transmits through a communications system to a ground station where the digits are reconverted into words and displayed in printed form on a receiver unit. Large volumes of information can be sent in a short time with reduction in chances of human error or ambiguity.

Portable Fuel Cell.—A 45-pound fuel cell, which can take the place of a 55-pound motor-generator or 60-pound battery pack, will soon be delivered to the Marine Corps. Developed by General Electric, the cell can operate at full power for a week, using 136 pounds of fuel. The unit is designed to power a small surveillance radar used to detect movements on the battlefield.

Space Antennas.—Lockheed Missiles and Space Division has fabricated a series of lightweight experimental antennas for the Air Force's Wright Air Development Division. The antennas—designed to fold into a small compact package and then to unfurl once the vehicle is in space—have been two years in development.

The antennas, fabricated from clear Mylar film such as that used for food bags or from ordinary aluminum foil reenforced by Mylar film, were produced in a wide variety of designs. One is a six-foot sphere, or balloon, and is highly directive for point-to-point communication.

Two other designs are the "conical spire," which resembles a Christmas tree, and the "log-periodic," a triangular affair along whose vertical structures elements radiate horizontally in a zig-zag pattern. Both are designed for wide coverage of the globe.

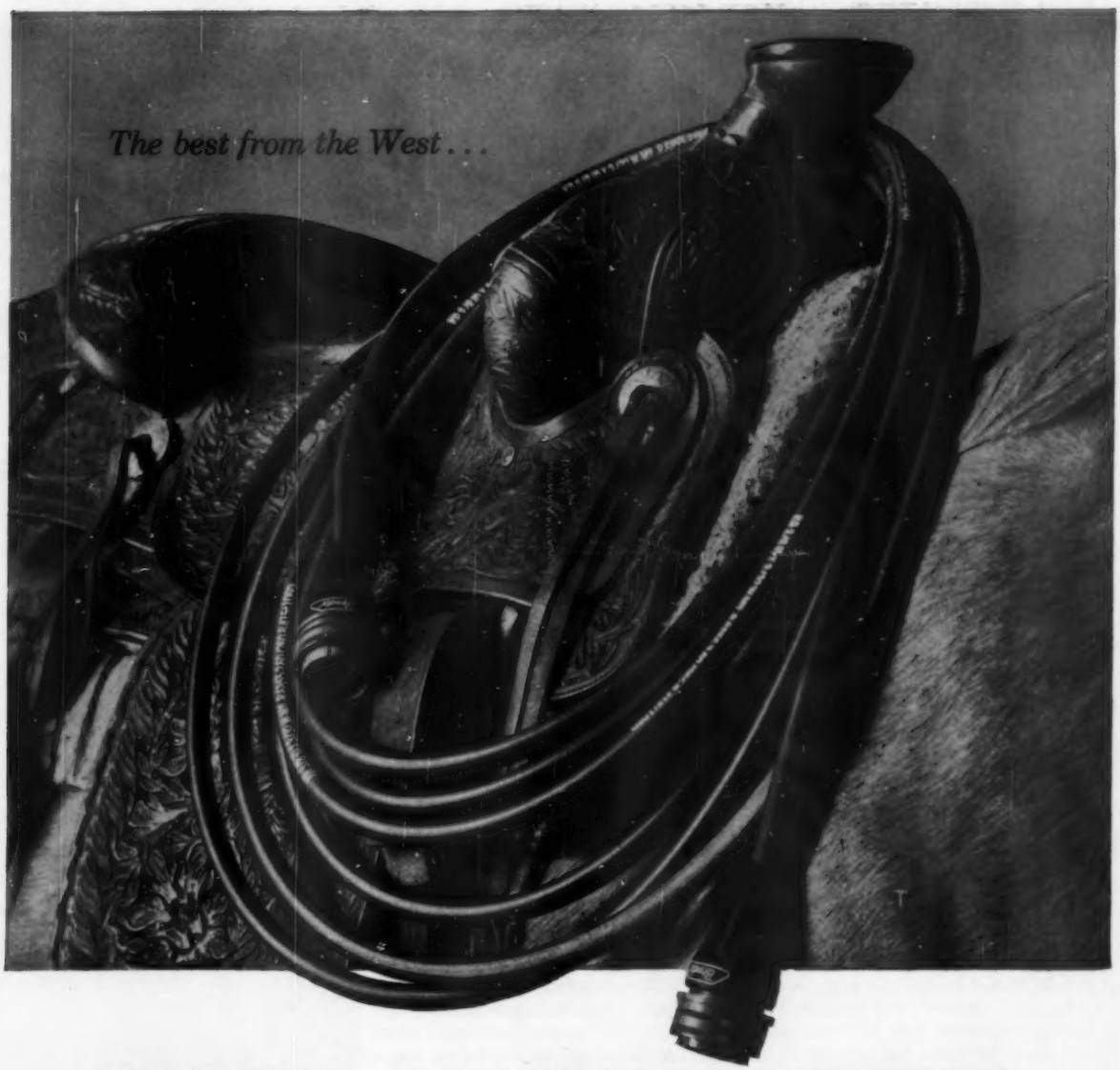
The advantages of unfurlable antennas are typified in the log-periodic type. Although its maximum dimension when erected is eight feet, its total weight is only twelve ounces and it can be folded into a package about the size of a cantaloupe. To inflate the tubes requires a pressure of only six pounds per square inch. When inflated, the elements of the structure become nearly perfect cylinders that are self-supporting after relief of the internal pressure. The sphere requires even less pressure to inflate.

The Air Force study also included design of mechanically operated antennas. One, called the rose petal, is a four-foot parabolic dish. Segmented into petals which enfold the nose of a satellite, it blossoms into a parabolic antenna once in space.

Tacan.—A contract for additional Tacan air navigational equipment for the U. S. Air Force's B-58 supersonic bomber and the T-38 jet trainer has been awarded to Hoffman Electronics Corporation. The contract is a follow-on to earlier Air Force Tacan orders and calls for production of the AN/ARN-65(V) airborne equipment. Airborne Tacan equipments are being produced under rigid reliability requirements set down by the Department of Defense's Advisory Group on reliability of Electronic Equipment (AGREE).

Acoustical Test Chamber.—Goodyear Aircraft Corporation has installed a large acoustical test chamber at its Litchfield Park, Ariz., plant to test the effect of sound on various aircraft and missile components. The chamber is capable of duplicating the noise produced by any jet

Mr. Van Vliet is a student of engineering and mathematics. He is active in amateur radio and also in experimental electronics.



QUALITY CABLES AND CONNECTORS NOW PRODUCED AT NEW BENDIX SANTA ANA PLANT

For users of electronic cables and connectors, Scintilla Division's new plant in Santa Ana, Calif., is an important addition to West Coast industry.

Here are the finest, most complete, environmentally-controlled, air-conditioned facilities in the area devoted exclusively to cable development and manufacture. For West Coast electrical connector users the Santa Ana plant with its complete facilities also offers "short-order" assembly service on the extensive line of Bendix connectors.

The plant is designed to meet the standard and special-purpose requirements of aircraft, missiles and ground-based electronic equipment.

Sales and service for cables and connectors and all other Scintilla Division products will still be handled out of 117 E. Providencia Ave., Burbank, Calif.

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or rocket engine. Power for the chamber's 112 loudspeakers is provided by two 10-kilowatt audio amplifiers.

ESAR.—Electronically Steerable Array Radar (ESAR), has been installed near Baltimore by Bendix Radio under sponsorship from the Air Force and Advanced Research Projects Agency. The radar is composed of over 8,000 small antenna elements mounted on a sloping surface 50 feet square. About 700 of these elements may be excited at any single time for simultaneous scanning and tracking of multiple targets. The radar is oriented to provide surveillance of missiles launched from NASA's Wallops Island station and to view air traffic between Baltimore and Washington.

Ultraviolet Communications.—According to tests conducted by Western Electric Company, the use of ultraviolet for space communications could provide many advantages over the use of radio frequencies. Tests indicate that ranges of twenty million miles with only one watt of radiated power are quite feasible. For an equal range using radio frequencies, radiated power would have to be one hundred or more times greater.

Not only would the ultraviolet communications system operate at a great savings in power but would require much smaller antennas—both important considerations for space vehicles. The narrow beam width provided by ultraviolet offers greater security than do radio frequencies, an advantage from a military viewpoint.

Ultraviolet communications will probably be limited to space use as the earth's atmosphere absorbs and strongly attenuates ultraviolet radiation. This problem could be solved by the use of an earth satellite to convert radio signals from earth into ultraviolet for relaying to the space vehicle. According to company scientists, lower frequency ultraviolet may not suffer this disadvantage, and might be usable for earth-to-satellite communications.

Saturn Checkout System.—A contract from the National Aeronautics and Space Administration has been awarded to Packard Bell Electronics for an automatic checkout system for the Saturn space vehicle booster. The contract calls for the development, production, and installation of an automated checkout system to replace manual equipment. The new system will be used for making mechanical and electrical tests on single components, subsystems, and completed boosters.

The series of tests will culminate in an electrically simulated vehicle flight. Each rocket will undergo these tests before being shipped to the launch site at Cape Canaveral, Fla. The automatic checkout system also may be used for other rocket systems, according to NASA, and will have the capability of being expanded or modified for the upper stages of Saturn.

Compact Voice.—A device that produces a "compact voice," designed to relieve the increasing traffic congestion on radio communications channels, has been built by Hughes Aircraft Company for the Air Force's Air Research and Development Command. Called a "vocoder," the device condenses a voice by ignoring redundant sounds in speech and transmitting only those sounds needed to make speech intelligible. As a result, the vocoder uses a narrower frequency band for transmitting. At the receiving end the vocoder reconstructs synthetic speech by means of electronic tone generators.

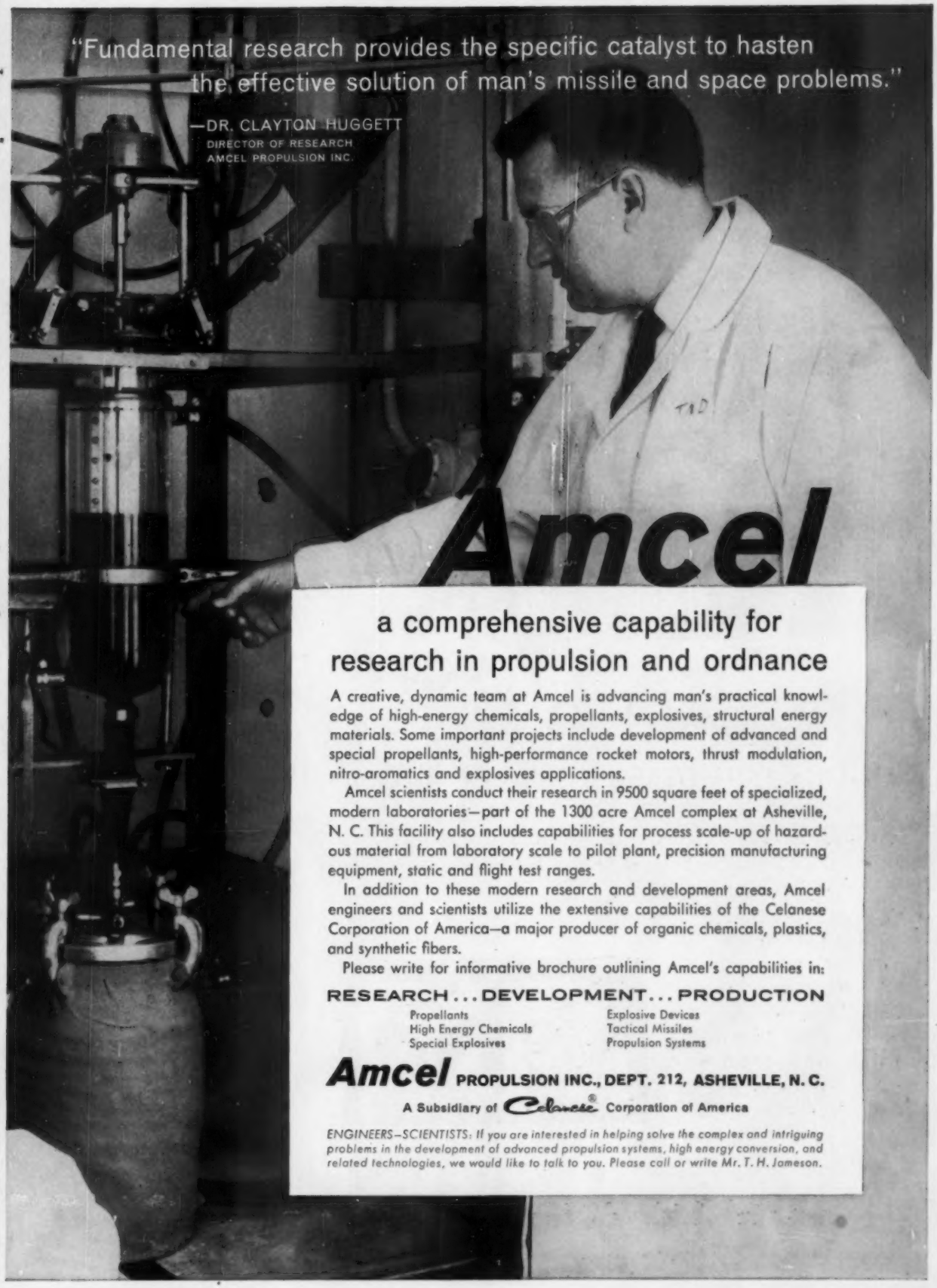
When used in the analog mode, a vocoder requires only a tenth of the radio bandwidth needed for speech transmission by conventional methods—an important factor in long-range communication because man has about run out of available radio frequencies. In a digital mode, voice is transmitted as a series of on-off pulses which improves reliability and range.

Vocoders were developed from an analysis of the mechanism of human speech production which showed that a large portion of speech sounds are redundant and can be eliminated without loss of intelligibility. Thus a significant saving in frequency bandwidth can be achieved by a device that develops signals in response only to those sounds in human speech that are essential for conveying intelligence.

Communications Change-over.—An Air Force Communications Service will be established to operate and maintain all Air Force point-to-point and air-to-ground telecommunications, except for weapons control systems. The service will replace the Airways Air Communications Service (AACS). The new service will become active in July and is expected to provide a more effective system, with great savings in cost and manpower.

Nike Zeus Computer.—The first Nike Zeus digital computer, part of the Army-Western Electric antimissile system, has been developed by Bell Telephone Laboratories. The computer will be installed on Ascension Island in the South Atlantic to collect and process reentry radar characteristics of missiles launched from Cape Canaveral.

The computer was constructed from information provided by an International Business Machines 704 computer. Using an automatic process called Bell Laboratories Automatic Design System (Blades), the IBM machine provided wiring diagrams, parts lists, and assembly instructions for construction of the Nike computer.


"Fundamental research provides the specific catalyst to hasten the effective solution of man's missile and space problems."
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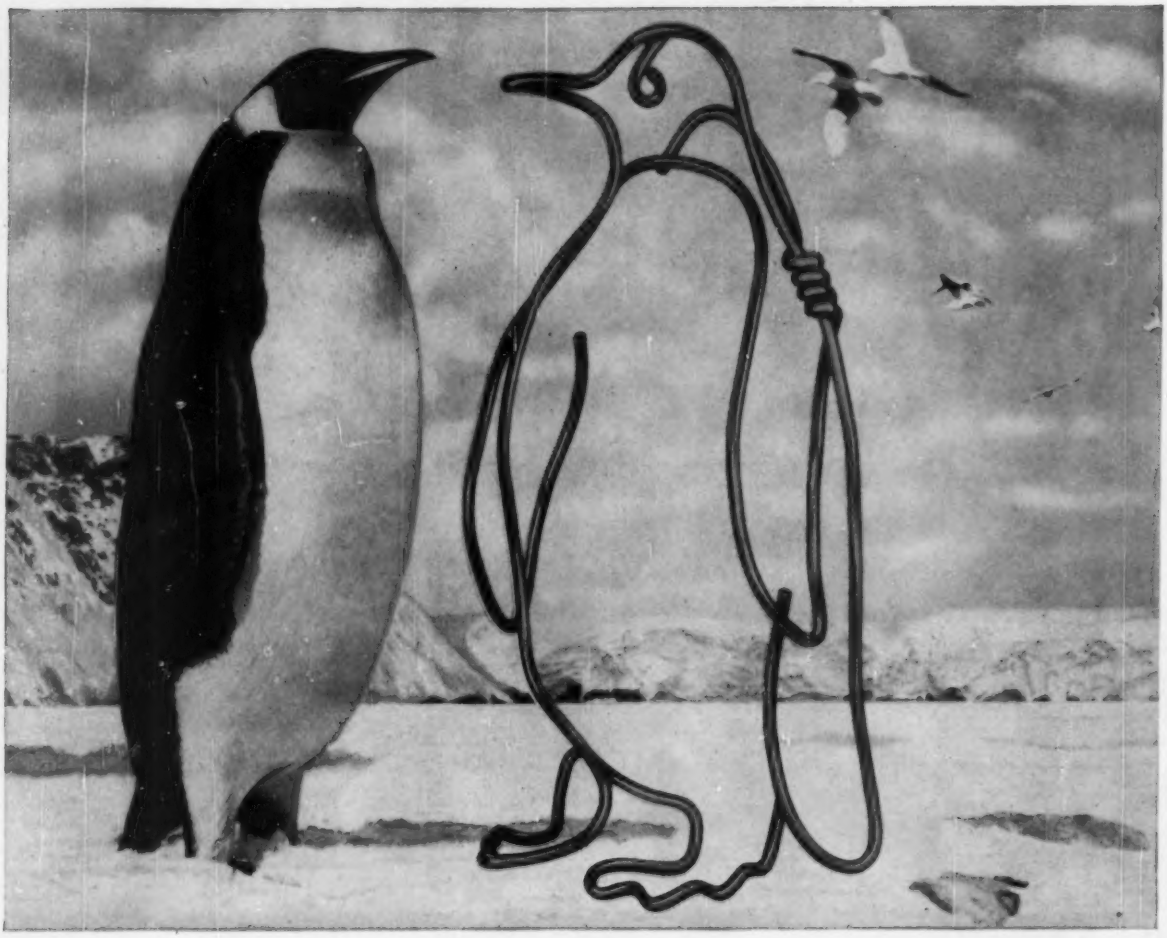

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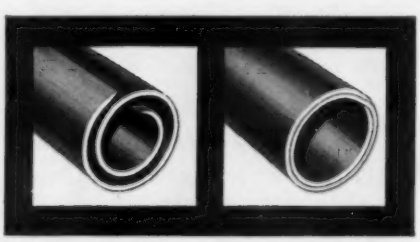

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Versatrac is a full-tracked, lightweight vehicle based on the proven design of the Hawk Missile Loader-Transporter. It can carry a load of men and material **equal to its own weight** through sand, snow, mud or water, and up a 60% grade. It can cruise, fully loaded, for 200 miles at a speed of more than 35 mph. It is air-transportable by helicopter or cargo plane, and can be dropped onto the tactical area by parachute.

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ROCKETS AND GUIDED MISSILES

Alfred J. Zaehringer

Atomic Rockets

Atomic rockets, particularly for upper stages, should be speeded up, say many quarters of the rocket industry. The upper-stage nuclear rocket would allow a tremendous increase in payload capabilities and would make America stronger in the rocket race.

North American Aviation, Inc., has stated that, if the U. S. can get going on a nuclear upper-stage engine system by July 1961, it could be flight tested in 1965-1966. In the case of the Nova booster, an upper-stage nuclear rocket would allow, for example, a 35-ton, 2-way trip to the moon, or could put 72½ tons into a Mars orbit.

A Saturn upper-stage nuclear engine has been outlined by NASA. First two stages would be chemical and the third would be atomic with a thrust of 37½ tons. A single nuclear stage could replace three chemical stages in a 5-stage vehicle and might double the payload capability of the vehicle. For example, a nuclear upper stage in Saturn would allow fifteen tons to be placed in orbit. In comparison, the all-chemical Saturn would allow the orbiting of only some 9½ tons.

Liquid Rockets

The highest known rocket thrust was achieved in the Rocketdyne firing of the F-1 engine at Edwards Air Force Base, Calif., on February 10th. Some 1.55 million pounds of thrust were recorded in a brief run at Test Stand 2A which towers 230 feet above the Mojave Desert. The stand has a 260-ton flame deflector and is cooled by 60,000 gallons of water a minute. The concrete and steel test stand can handle two such engines. The F-1 engine will undergo flight-rating tests in 1962 and is expected to be ready early in 1963. It is the largest single-chamber liquid rocket engine in the United States and derives its power from the combustion of liquid oxygen and a hydrocarbon fuel similar to kerosene.

NASA now has a program to look beyond Saturn and has awarded three contracts to consider rockets with first-stage thrusts of six to twelve million pounds. In addition to considering liquid propellants, however, the studies will investigate solids and nuclear fuels. In addition, one part of the program will study the attractiveness of a large, high-energy, liquid hydrogen-liquid oxygen booster. The hydrogen fuel system now is being developed only for relatively small upper stages.

Developments on this nation's largest rocket—the Saturn—continue rapidly. Tanks for five boosters will be built under a recent NASA contract. Each first-stage booster is made up of nine tanks, one 105-inch-diameter LOX tank centered in a cluster of eight 70-inch-diameter tanks (half containing LOX, the other half containing RP-1 kerosene fuel).

The Saturn booster has an over-all diameter of 22 feet and is 82 feet long. Its thrust of 1.5 million pounds comes from a cluster of 8 H-1 engines of 188,000 pounds' thrust each. A pyrophoric fuel slug is used for starting. A solid-propellant charge starts up the turbopumps, each of which has a 3,800-horsepower rating. The fuel flow rate is 2,100 gallons a minute while the LOX flow rate is 3,200 gallons a minute.

The impact of the burning of 37½ tons of propellant in a little over two minutes' burning time is made clearer if translated into a possible human situation. Imagine 55 million people riding full throttle down the highways all at one time in 28 million small cars each with a 35-horsepower engine. All these people would be breathing oxygen at the rate of Saturn while the cars would be burning fuel at Saturn's rate!

Saturn recently completed successful tests at the NASA Marshall Space Flight Center, Huntsville, Ala. The last test was for approximately 110-128 seconds' duration. The C-1 Saturn will be able to put 9½ tons into a 300-mile earth orbit, to send 2½ tons to escape velocity, to put 2 tons into a 24-hour earth orbit, or to send 1¼ tons to Mars or Venus.

This spring will mark the start of static tests of the first flight booster. Research and development launchings are expected to begin this year with dummy upper stages and with delivery of an operational prototype for firing in 1964.

Liquid propellants chalked up a new speed record on March 7, 1961, when a pilot flew the X-15 rocket plane at a speed of about 2,760 miles an hour. Power came from a 57,000-pound-thrust rocket engine burning LOX and liquid ammonia. Ultimately the craft is expected to reach speeds of 4,000 miles an hour and to attain an altitude of 50 miles.

Titan J carried the new Mark 3 reentry nose cone in a recent flight test at Cape Canaveral. Titan I, in its operational version, will carry the heavier Mark 4 warhead. Mark 3 has been used with a number of Atlas flights.

Hydrazine, long-known high-energy fuel for liquid rockets, looks like it will be more attractive in the future. Several groups have been reported considering its production directly from ammonia via irradiation. Such techniques might drop the cost by about one-tenth of present prices and make it available in larger quantities. Hydrazine-type fuels are already being planned for in storable versions of the Titan ICBM, for example.

Titan II would be 2-staged (each stage, 120 inches in diameter), have a total length of about 108 feet, a launch weight of 270,000 pounds, and be able to carry a 5-megaton warhead to a range of 10,000 miles. Propellants would be nitrogen tetroxide oxidizer and a mixture of unsymmetrical dimethyl hydrazine and hydrazine as fuel.

Solid Rockets

Hard on the heels of the first successful orbiting of a satellite by an all-solid rocket (80 pounds by an "Explorer IX" Scout on February 16, 1961), the Air Force Blue Scout II lifted a payload of 172 pounds to an altitude of 1,600 miles. Firing took place from the Atlantic Missile Range on March 3, 1961. All four stages worked perfectly, and the vehicle burned up as it reentered the earth's atmosphere some 2,000 miles down range.

The payload package was provided by the Air Force Special Weapons Center, N. Mex., and was designed to make radiation measurements of the Van Allen Belt surrounding the earth. First stage is an Aerojet Senior rocket; stage two is the Thiokol XM-33; stage three is ABL X-254; stage four is ABL-248.

Two static tests of solid rockets were also in the news. First, the U. S. Army Ordnance Missile Command at Redstone Arsenal announced the successful firing of an improved high-energy, solid-pro-

Mr. Zaehringer, president of the American Rocket Company, Wyandotte, Mich., is a recognized authority on astronautics, guided missiles, and jet propulsion.

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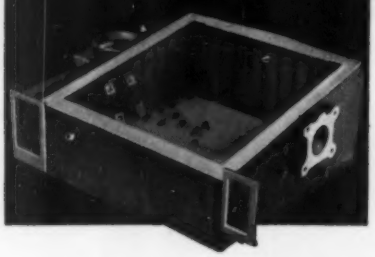

AiResearch integrated environmental conditioning of aircraft fire control systems achieves high effectiveness while reducing space and weight requirements.

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Rockets & Missiles (Contd.)

pellant rocket motor using a lightweight and high-strength motor case made of titanium. The case was thirty per cent lighter than a steel case and made the motor "the highest performance, full-size, metallic propulsion unit, pound for pound, ever successfully fired in the United States," according to the Army. The case was jointly designed by Thiokol Chemical Corporation and Pratt & Whitney. The test ran for forty seconds.

Rocketdyne's Solid Propulsion Operations announced that it had fired a large solid motor, containing 3,500 pounds of propellant, at a temperature of minus 75 degrees Fahrenheit. The motor had a diameter of thirty-eight inches and was about seven feet long. Before firing, the motor had two temperature cycles between minus 75 and plus 170 degrees Fahrenheit. The motor employed an internal-burning star-grain case bonded to the metal case. Previously, Rocketdyne Division of North American Aviation, Inc., had announced the firing of a swivel-type nozzle solid-propellant motor.

Metal coolants for solid nozzles were revealed by Aerojet-General Corporation. One nozzle ran at 6,200 degrees Fahrenheit for 80 seconds and used a molybdenum wall and magnesium coolant. Melting, boiling, and evaporation of the metal cools the nozzle. Weights are comparable to conventional nozzles which are uncooled. The tests indicate that solids might be able to operate at combustion temperatures of 6,500 degrees Fahrenheit by 1967 and hybrid propellant (solid-liquid) operations at 7,300 degrees Fahrenheit.

Glass rockets—glass fibers with plastic filling—have been making steady gains for solid motors. According to the U. S. Naval Ordnance Laboratory, lightweight rocket motors will result from nonwoven (roving) glass fiber and plastic. The Navy laboratory has developed a tensile tester for determining the strength of plastic rocket motors.

The new A-2 Polaris missile has a 300-mile range increase over the present A-1 version due to a new glass-plastic second-stage motor. According to Hercules Powder Company, the manufacturer, this case is made from 267,930 miles of continuous glass filament. To make the case, parallel bands of glass fiber and the resin binder are placed over a rotating mandrel in a pattern (helical) to give maximum strength.

Additional work, to the tune of over $2 million, will take place on the Nike-Hercules missile system. A second Army missile, the Pershing, got another boost with a successful firing on March 1, 1961. The firing utilized all components of the tactical inertial guidance system. The missile was fired from its mobile-transporter-erector-launcher, the fully

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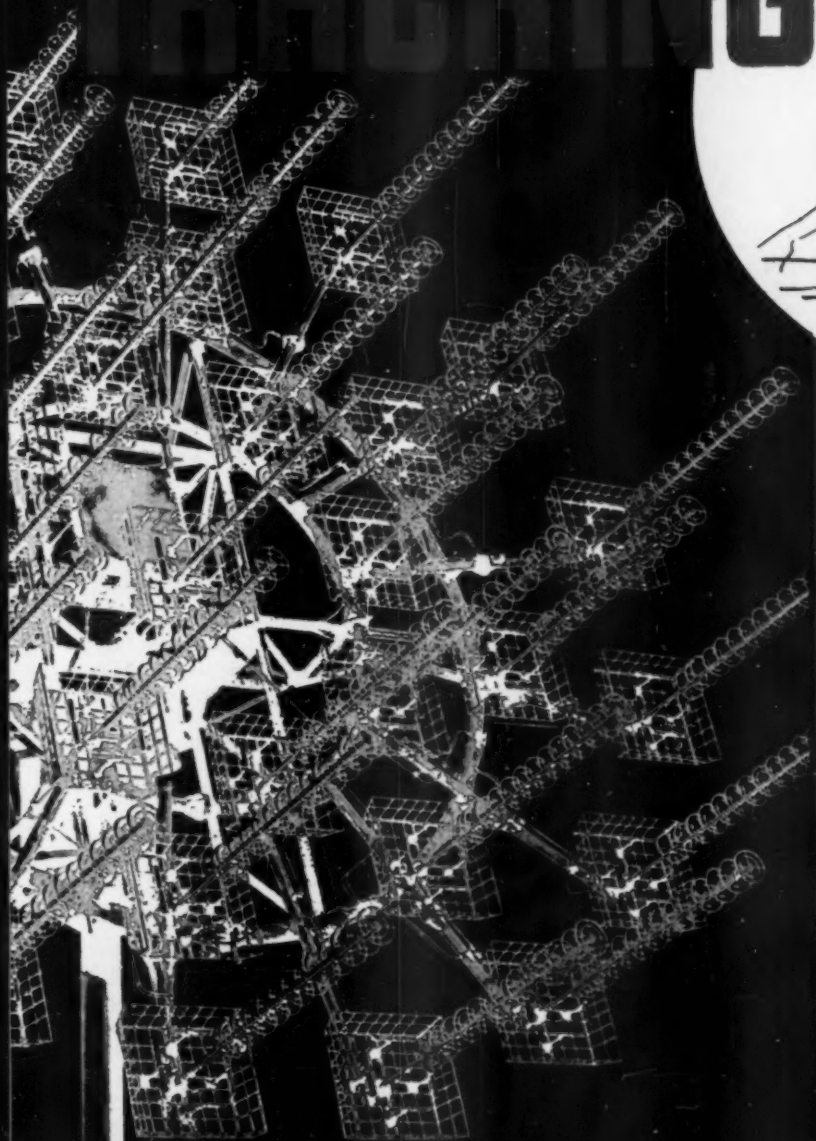

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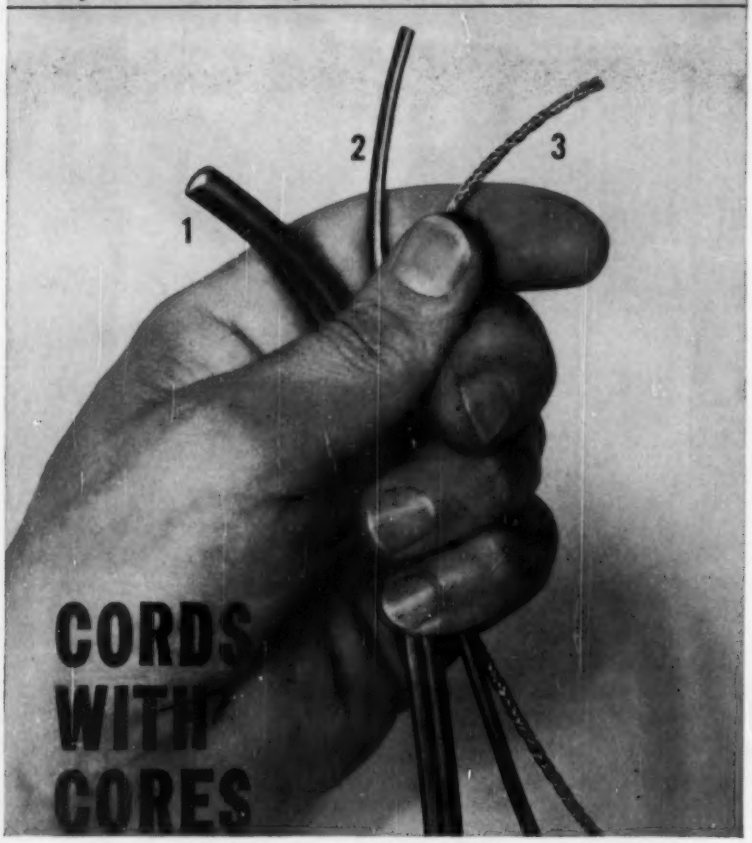

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Rockets & Missiles (Contd.)

tracked XM474. Both stages performed properly.

The Pershing is a surface-to-surface missile with a range of about 300 miles in its present 2-stage version but which could be extended to give 1,000 miles. Physical features: 38 inches in diameter, 40 feet long, launch weight of about 25,000 pounds. The warhead will be nuclear.

On February 1, 1961, the first firing of the Air Force Minuteman ICBM was made and was described as a complete success. Launched from Cape Canaveral, all stages functioned and a payload package impacted some 4,000 miles down range in the Atlantic Ocean. The 3-stage rocket has a first-stage thrust of 170,000 pounds; second stage, 55,000 pounds; and a third stage thrust of 35,000 pounds.

The firing took place from a conventional pad, but others in the series will be from underground silos later this year and from a mobile railway car sometime in 1962. Ultimate range will be around 6,000 miles for this missile which weighs 70,000 pounds at launch. The missile is about 59 feet long, and has a diameter of approximately 70 inches. The warhead is around 2 megatons and the guidance system is entirely inertial.

Several new developments also loom large in future solid rockets. Aerojet, for example, has demonstrated its segmented or "bolt-together" rocket. Such techniques would make possible a wide variety of rockets from a few basic building blocks.

Spherical motors are being looked at as possibly giving the most performance from a given volume. Such motors would be used in upper stages, in space, or possibly for retro-thrust for recoverable satellites or for soft landings on the surface of other planets. Aerojet and NASA both have published studies recently on spherical rocket motors.

Meanwhile, Space Technology Laboratories has come up with a consumable case for solid rockets. By burning the rocket case as the grain is burned, for example, some 700 miles added range can be given to an all-solid ICBM.

At the Air Force Arnold Engineering Development Center, Tullahoma, Tenn., a sunken shaft is being constructed which can test solid rocket motors of up to a half million pounds of thrust under simulated high-altitude conditions.

Ion Rockets

Ion rockets which are looked on as "lazy" propulsion methods have been under development for quite some time. A tabulation reveals that there are some 25 contracts now in effect with a total contract cost of over $3 million. In addition, some eight contracts have been completed. (*Continued on p. 854*)

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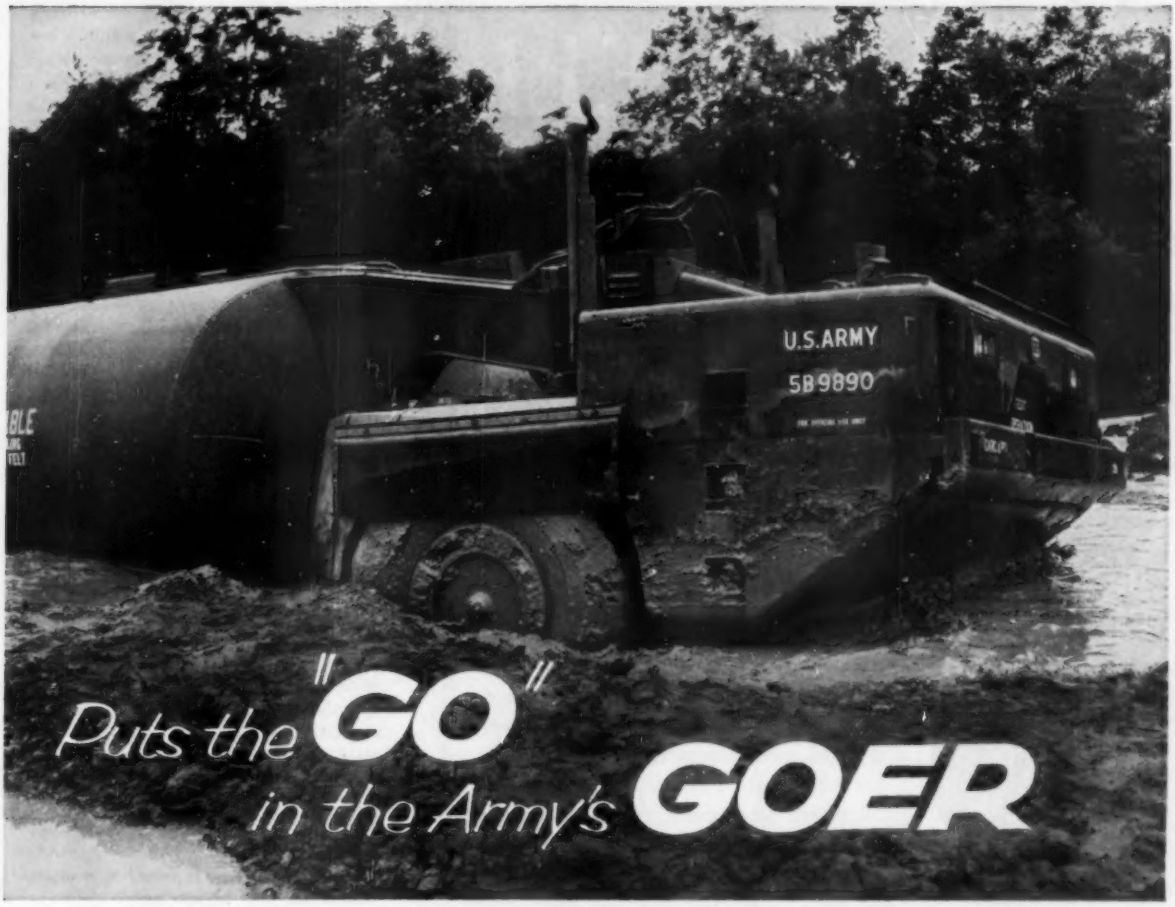

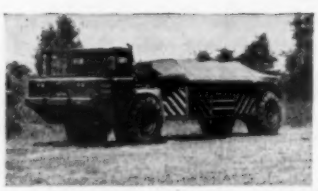

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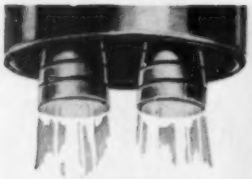

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Rockets & Missiles (Contd.)

Very low thrust devices have been demonstrated in the laboratory, but it still is not known how they would work in space. It is expected that within a few years a working model of an ion rocket can be put into space to see how well it would perform. But on the ground, the big concern seems to be the development of low-weight, efficient power sources for the ion drives.

Antisatellites

Now that satellites can be put up with better certainties, there are several projects underway concerned with shooting them down! Despite the fact that the military potentials of space platforms have yet to be demonstrated, there is work on defense against them. There are at least three such systems which have been partially identified as antisatellites. Dog Leg is a Navy program involving a lightweight satellite that can destroy other satellites via its nuclear charge. Notsnik is a proposal by the U. S. Naval Ordnance Test Station at China Lake, Calif., for an aircraft-launched antisatellite rocket—a sort of Mighty Mouse with vitamins!

The Air Force Saint (from *Sa*tellite *In*terceptor) would be anything but "saintly" in that it would carry payloads of 2,000 to 4,000 pounds which would be placed into orbit and which could rendezvous with and intercept unknown satellites. An Atlas-Agena B would orbit Saint, which would be equipped with TV and homing radar. Another, Somnium, is a classified ARPA satellite program which may also be an "anti."

Bird Talk

Despite the increased emphasis on space rockets, the old rocket "birds" or aircraft rockets are not being neglected. The Navy-Air Force Bullpup A which started out as a solid rocket is now being replaced with prepackaged liquid engines. The Bullpup B has a 5-mile range (double that of the A model) and is being funded at least until 1964. Production could continue, however, throughout the 1960's.

The Eagle is the latest bird under development. This Navy missile has a range of about 100 miles, a speed of Mach 4, and a launch weight of around one ton. Work is now proceeding on a multimillion dollar contract. Length is about 16 feet and diameter around 2 feet.

The nuclear Falcon 11 has a range of about 5 miles and carries a nuclear charge estimated at 1½ kilotons. Length is 7 feet, diameter around 1 foot, and launch weight over 200 pounds.

Other Falcons are the radar-guided GAR-3A and the infrared-guided GAR-4. Both can operate at extreme temperatures and higher than the jets that carry them.

MISSILE SUPPORT EQUIPMENT

Robert S. Sartoris

Aerospace Ground Equipment.—Indication of the coming of age in support equipment is a new designation system established by the Air Force. The new label to cover all operating and maintenance type of equipment required to make any aerospace or end item work is "Aerospace Ground Equipment" (AGE).

AGE is defined by the Air Force as all equipment required on the ground to make a weapon system, command and control system, support system, advanced objective, subsystem, or end item of equipment operational in its intended environment.

This includes all equipment required to install, launch, arrest, guide, control, direct, inspect, test, adjust, calibrate, appraise, gage, measure, assemble, disassemble, handle, transport, safeguard, store, actuate, service, repair, overhaul, maintain, or operate the system, subsystem, end item, or component. This definition applies regardless of method of development, funding, or procurement.

Under the classification of AGE there are two breakdowns, OGE, for Operating Ground Equipment, and MGE, for Maintenance Ground Equipment.

Launch Site Jurisdiction.—Following the recent reorganization of research, development, and procurement functions of the Air Force, construction of ICBM launch sites will fall under the Ballistic Systems Division of the new Air Force Systems Command. Lieut. Gen. B. A. Schriever, former commander of the Air Research and Development Command (ARDC) at Andrews Air Force Base, will head up the new command.

The new Ballistic Systems Division is composed of elements of the ARDC Ballistic Missile Division and the Air Matériel Command (AMC) Ballistic Missile Center, which operate side by side at Inglewood, Calif., and the Army Corps of Engineers Ballistic Missile Construction Office (CEBMCO), which is in charge of all ballistic missile base construction.

As Deputy for Site Activation under the Ballistic System Division, Brig. Gen. Alvin C. Welling, commanding general of CEBMCO, will be in charge of all site construction. He will be aided by Col. Thomas J. Hayes, III, vice commander.

Following reorganization late last year of the Corps' launch-site construction alignment, site-construction authority will continue to be broken into specific sites instead of being controlled on the regional basis historically practiced by the Corps.

General Welling is in charge of facility design, construction, installation, and checkout. In the field, at each operational location, the present site-activation task forces of AMC will be combined with existing field detachments of ARDC and Corps of Engineers detachments to form an integrated team responsible for the complete site-activation task.

Directors assigned to the sites by the Engineers are: Col. Carlin H. Whitesell, Titan I site; Col. Carroll H. Dunn, added Titan generation sites; Col. Woodrow W. Wilson, Atlas F site; and Col. Charles C. Noble, Atlas D and E and Minuteman. Atlas D and E sites, already well into construction, remained under the old Corps of Engineers District supervision, answering to CEBMCO only for general over-all authority.

Atlas Sites Readied.—Schilling AFB, near Salina, Kans., is the first of six SAC bases destined to receive 174-foot-deep "hard" underground Atlas launching silos. Each base will have twelve such installations, widely dispersed.

Atlas sites consist of two major structures, the silo, for the missile and most of its ground-support equipment, and a launch control center (LCC) located about one hundred feet away, all below surface. Silos are 174 feet deep and 52 feet in diameter, with concrete walls varying from 2 to 9 feet in thickness, depending on soil conditions. The finished walls will withstand pressures up to 3,500 pounds per square inch. In constructing the sites, optical tooling devices are required to meet tolerances of thousandths of an inch in positioning certain fixtures with no margin for variation.

Missile Facility Problems.—Launch-site construction, already a billion-dollar-plus industry, has required more exacting techniques and more concentrated management than any previous Corps of Engineers project. The work, handled largely by the construction industry under direction of the Corps, involves far tighter tolerances than the industry is accustomed to.

In launching facilities for the first Titans and latest Atlas missiles, underground silos could house a 13-story building. In such facilities, engineers must erect precision framework for supporting the missile and for operating all equipment involved and install electric power plants, air conditioning, mechanical equipment, and fuel-handling systems along with complete operational and living quarters for the Strategic Air Force crews who will man the missile-firing installations.

Some of the problems faced by civil engineers include the wide temperature ranges, from plus 100 degrees to minus 320 degrees Fahrenheit involved in liquid fuel handling systems, with pipes and valves requiring pressures of thousands of pounds per square inch and pumping capacities of several thousand gallons per minute. Adding to their difficulties is the requirement for absolute cleanliness in building facilities for handling oxygen in which a single medium-sized particle of contamination could easily contribute to an explosion.

Electronics for Titan.—Hughes Aircraft Company has been selected by Martin for assistance in activating a Titan launch site at Mountain Home, Idaho. Hughes will check out electronic launch equipment and missile systems and help Martin deliver an operational base to the Air Force's SAC teams.

The Mountain Home base is one of nine being activated by Martin. It will consist of three missile complexes, each having three 160-foot-deep silos protected by heavy steel and concrete doors. Titan I will be based at Mountain Home; Lowry AFB, Colo.; Beale AFB, Calif.; Larson AFB, Wash.; and Ellsworth AFB, S. Dak. The larger, longer-ranged Titan II will be based at Davis-Monthan AFB, Ariz.; McConnell AFB, Kans.; Little Rock AFB, Ark.; and Griffiss AFB, N. Y.

Each time a Titan ICBM hurtles down the Atlantic Range on a 32-minute, 6,000-mile test flight, it writes its own electronic biography on 18 miles of magnetic recording tape. Inscribed on the tape are some 300 measurements flashed by radio signal to recording machines at Canaveral and other tracking stations along the Atlantic Range. (*Continued on p. 858*)

Mr. Sartoris is on the staff of Boeing Airplane Company, Seattle, Wash.

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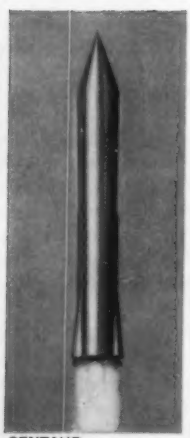

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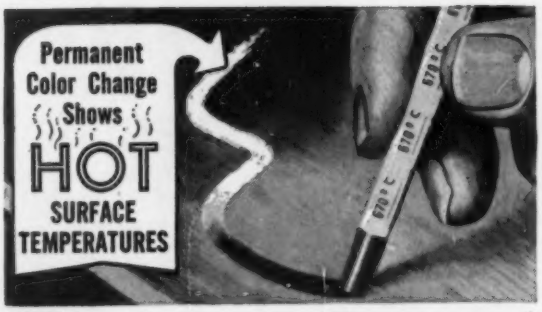

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Missile Support Equipment (Contd.)

Within two hours these tapes are processed and give the experts a quick look at the missile's performance, telling how each piece of hardware in the missile functioned and where trouble spots might have occurred inscribed on some eight or nine miles of paper. To date, according to the Martin Company, prime contractor for the missile, more than 1,300 miles of tape and film recordings have been collected, giving engineers a complete look at the inner workings of the bird they created.

Tracking by Camera.—Tracking of an Air Force Titan ICBM, launched down the Atlantic Range from Canaveral in February, was accomplished by cameras installed at downrange tracking stations that recorded the Titan's flight on film. An electronic blinker, powered by a small battery, flashed a 22-million-candlepower light at half-second intervals during the final phase of the second-stage flight. The ICBM's path shows up as dots on the tracking cameras' film. Analysis of intervals between the dots and their position relative to certain stars provides precise speed and location data about the flight path.

Minuteman Moves Ahead.—Silo and launch facilities for Minuteman have begun to be constructed at Vandenberg AFB, Calif., under a $2.5 million contract with Stolte Construction Company. Launch facilities will include rail spurs for mobile emplacements. Complete facilities will include two control centers, one above ground and one below, plus a destruct package building. The latter will house materials used in test and training launches for range safety in event of a malfunction.

Construction has also begun on the Malmstrom AFB, Mont., Minuteman ICBM launching complex. Ground breaking inaugurated a $61 million program involving construction of 150 underground launching silos and 15 concrete underground control centers.

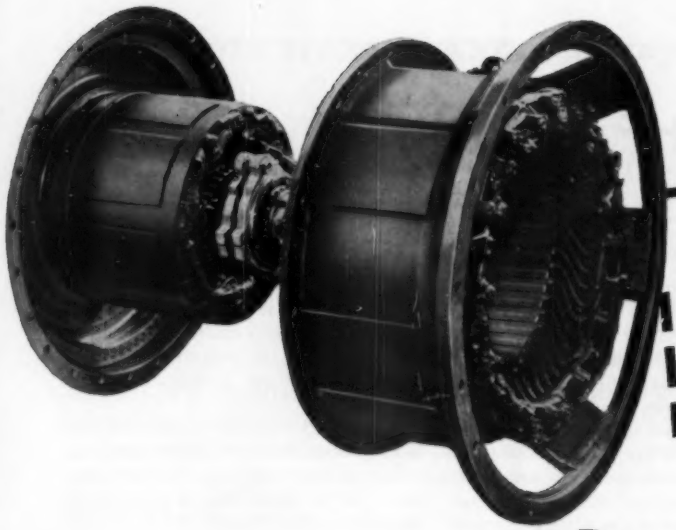
Ellsworth AFB, S. Dak., is under discussion as still another Minuteman installation with underground launchers for as many as 150 missiles. The site is a support center for a 9-missile Titan squadron now under construction. Another Minuteman complex may be located near Pease AFB in New Hampshire and two mobile railroad squadrons are now under discussion for operation out of Hill AFB, Utah.

Soft Ride for Polaris.—Polaris is riding to work on an air cushion. To protect the 28,000-pound IRBM while in transit from factory to launching tubes, it is inserted in a special liner tube which, in turn, is cradled on ten air-spring assemblies and sandwiched between similar assemblies attached to each end of the case.

The air-cushion system, using standard Goodyear rolling lobe air springs similar to those used on Atlas missile transport trailers, dampens railroad shock from 44-g longitudinal and 17-g vertical loads normally experienced on a flatcar, to only 2.6-g longitudinal and 2.5-g vertical loads, the latter well within Polaris design tolerance.

New Safety Systems.—General Mills, Inc., is developing a safety system for handling rocket motors and fuel. The system will permit personnel to remain safely behind barriers while loading propellants, attaching nozzles, transporting to test stands, and positioning the bird for firing.

Lightweight Air Conditioner.—A lightweight, compact air-conditioning unit capable of delivering 50,000 Btu an hour, but weighing only a third of conventional units, has been designed for use in control vans for Hawk and Sergeant missiles and is now under test by Army Engineer Research and Development Laboratories, Fort Belvoir, Va. Weight and size reductions are gained by adaptation of aircraft-type components.



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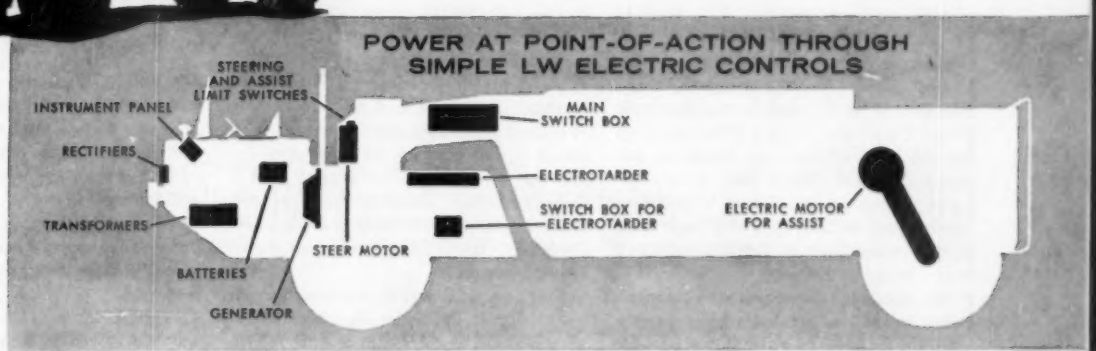

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FROM THE RECORD

The Army's Mission

HON. ELVIS J. STAHR, JR.
Secretary of the Army

ALTHOUGH all the members of our armed services would be essential to victory in limited war, it cannot be denied that land units would play the dominant role under almost any circumstances. However, the Army is by no means primarily a limited-war force. In an all-out war the Army will have a most significant role, which may not be as generally recognized as it needs to be. Our Army must have the capability in general war to meet and defeat enemy forces in the wake of the damage caused by nuclear exchanges. It must then be prepared to exercise direct, full-time, and comprehensive control over the land, the resources, and the peoples of the enemy.

The Army will also play a key part in the defense of the United States from enemy attack through the air. In this connection, I submit that we must continue, as a matter of high priority, to develop an effective antimissile defense.

In preparing to rebuff any kind of aggression—all-out nuclear aggression or anything less—it seems obvious to me that we must maintain United States combat-ready forces overseas. The American serviceman on the ground is a living symbol of our readiness to contribute to the common defense—a symbol that allied people and the aggressors can both see—a visible and effective deterrent against limited aggression and an indispensable element in meeting it if it occurs. . . .

Another essential element in our forward strategy is the ability to reenforce rapidly our forces overseas. This capability would be required in all forms of war. Our active Army maintains forces in the United States for this purpose, three divisions of which are in the Strategic Army Corps, the Army's "fire brigade." Beyond that, we have the forces of our Army National Guard and Army Reserve. These reserve forces, I am convinced, must be kept at a very high state of combat readiness to support our active Army in an emergency.

We also must have available sufficient airlift to get our combat reenforcements where they have to go with all possible speed. In this connection, it should be noted that timely action already has been taken by the Administration to beef up our Air Transport fleet by the immediate procurement of a substantial number of additional cargo planes which will, in President Kennedy's words, "better assure the ability of our conventional forces to respond with discrimination and speed to any problem, at any spot on the globe, and at any moment's notice."

It seems evident to me that the attainment of virtually every defense objective depends to a major extent upon the complete, perceptive, and sustained cooperation of American industry and our armed forces. The necessity of being ready for commitment to any point on the globe creates requirements in all the services for weapons and equipment without parallel in our history. Our combat forces of all types must be able to react faster, cover more ground, protect larger areas, disperse and regroup faster than ever before. Defensively, they must be able to concentrate quickly and in sufficient strength to halt and defeat an enemy attack without themselves becoming a likely nuclear target. This requires greater firepower, mobility, and command control than ever before.—*Given before the Electronic Industries Association, Washington, D. C.*

Search for Reliability

LIEUT. GEN. B. A. SCHRIEVER
Commander, Air Research and Development Command

THERE is a new technical area now emerging as a major field of interest to my Command. The Air Force always has been concerned with reliability. We are now interested in the reliability that can be achieved in electronic and servo subsystems by patterning their functions on the behavior of living organisms.

In September of this past year it was my privilege to address a symposium at the Wright Air Development Division in Dayton, Ohio, convened to explore this new area of technology—bionics. As I stated at that meeting, when we consider that the human brain contains at least a thousand billion neural elements, we can understand that these may provide models leading to significant contributions to miniaturization.

This is a goal which deserves our utmost efforts; for under these conditions such mishaps as total catastrophic failure could become a thing of the past. If we analyze how living mechanisms operate, we see that although they can be damaged, in the majority of cases operation is still possible. While this means degraded functioning, if the threshold is high enough, it is operational none the less. This philosophy can mean significant improvement in the total reliability and effectiveness of our guided-missile and space systems.

When such concepts were postulated in the premissile and presatellite era, they were not readily accepted. Reliability was based on the availability of an adequate maintenance environment. We must think in terms of the new requirement for space systems. Reliability must take on a new meaning. We are interested in satellite systems having at least an 8,000-hour operable life with zero maintenance. This will place heavy demands on industry, both in the areas of miniaturization and reliability.

Another area in which significant advances have been made is in the molecular electronics programs. Today these programs are evolving from the early beginnings of little more than sophisticated, integrated circuits to the point where we are now employing the basic characteristics of the materials to provide electronic functions. . . .

The lessons of the past should make it clear that unparalleled opportunities await us in the age of space. I personally believe that the immediate future will be both the most exciting and most challenging era ever faced by man. It is an era ripe for progress, but remember the words of the slogan—"The future belongs to those who prepare for it."—*Given at the Fourth Annual Miniaturization Awards Dinner, New York, N. Y.*

The Challenge of Space

ADM. ARLEIGH BURKE
Chief of Naval Operations

CONTROL of the seas was a vital principle of warfare long before oars gave way to sail. And control of the seas will continue to be vital long after the nuclear reactor gives way to some yet-undiscovered source of power. To many, of course, the most dramatic and imaginative advances are being made in space, in astronautics. Here, man is just on the threshold.

In 1961 we are looking at space the way we looked at aviation in 1910. Just as we did then, we can forecast a few capabilities with high assurance, but others will unfold only with continued experiments. (*Continued on p. 863*)

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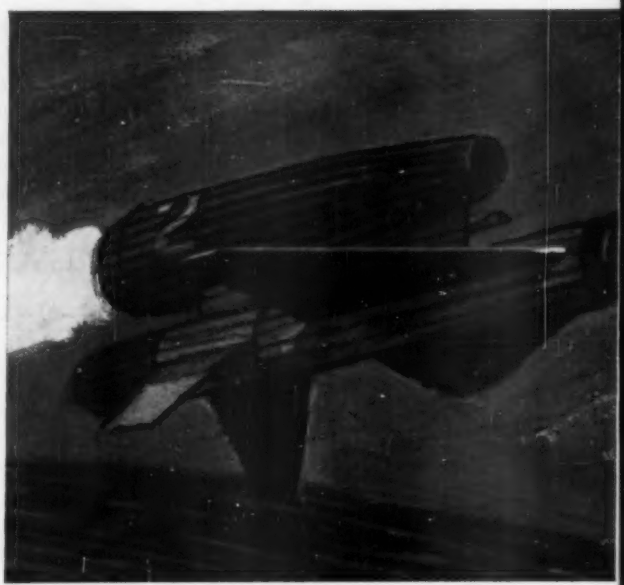

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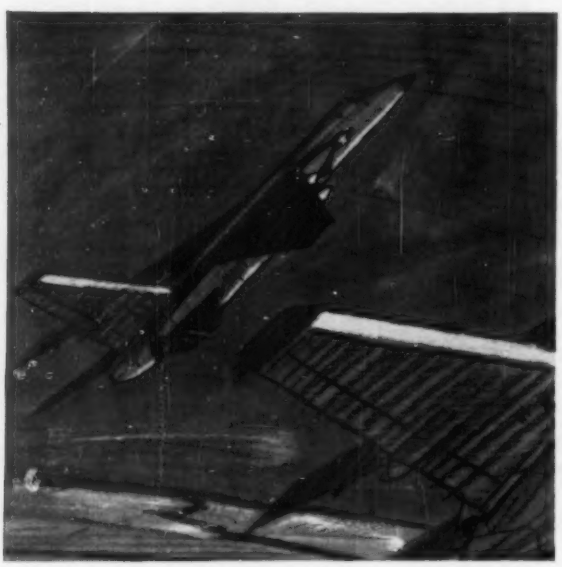

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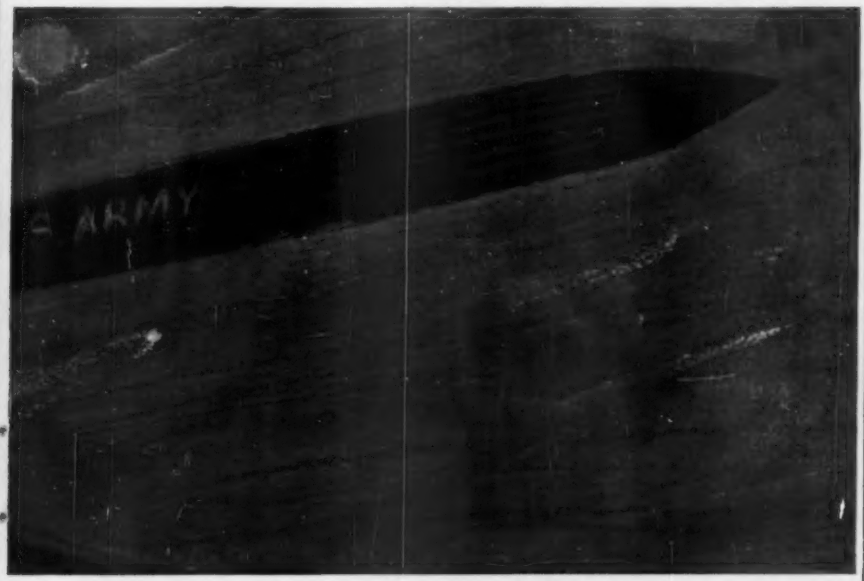
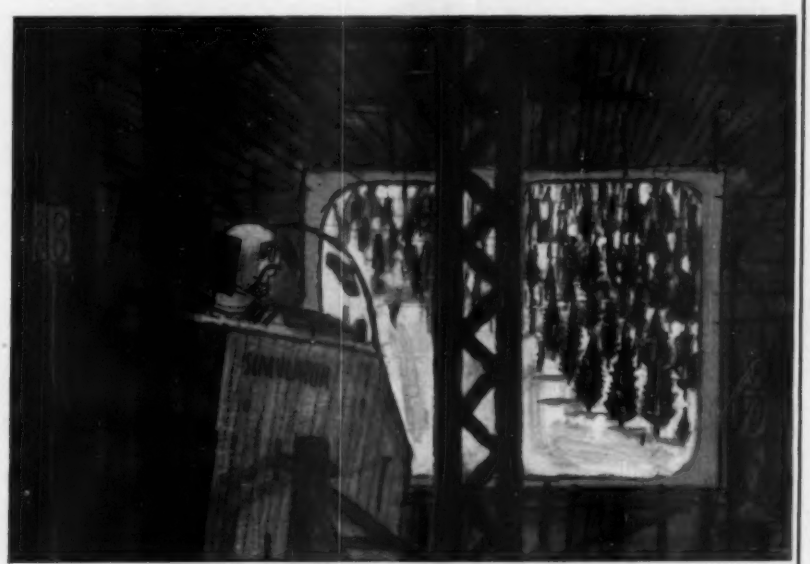


TWO-IN-ONE TARGET MISSILE. New target missile NA-273 can carry out high- or low-level missions equally well. It performs from ground level to 60,000 feet, and from subsonic through Mach 2. Under development for the Army by the Columbus Division, it is launched by a rocket, and powered in flight by ramjet



V/STOL FACILITIES. New six-degree-of-freedom flight simulator is part of facilities set up by Columbus Division to study requirements of vertical and short takeoff and landing aircraft design and development. Other V/STOL facilities include low-speed to transonic wind tunnel and unique lightweight ejection seat.

From the Record (Contd.)

We face hazards to human beings in space that will tax the talents of our nation's best medical scientists. What will happen to a man who is weightless for an extended period? What affects will space travel have on body fluids, on blood circulation, on muscle tissue? How can we shield man from the deadly effects of cosmic radiation? Our knowledge of the space environment is just beginning.

Someday man will set foot on the moon. Someday man may even explore the reaches of outer space. But whatever break-throughs occur, the Navy, of course, will be most interested in those space programs which will permit us to do our naval job more effectively here on the earth's surface. The Navy has already proved the feasibility of using space satellites for navigation purposes.

In just a few years the Transit satellite navigation system will be operational, furnishing amazingly accurate positions to our forces in all kinds of weather. In the future, satellites will provide communications to link our widespread fleets.

Weather satellites, already a proven concept, will provide worldwide weather data for analysis and forecasting. Reconnaissance satellites will relay tactical data to control centers where our commanders will put computers to work on the imponderables of battle. Space technology will improve the tools of command, so necessary to control the tools of war.

Yet in addition to the unknowns of outer space, there exists another vast area within the boundaries of our own planet, whose mysteries also remain unsolved. The conquest of "inner space," the exploration of the unfathomed depths of the seas, presents another great challenge. The riddles of the seas are countless. Today we know more about the surface of the moon than we do about the floor of the oceans.

From our study of marine life we know that some of these animals possess well-developed abilities in navigation, detection, and communications. These capabilities in many cases are better than the Navy's best equipment. Why, for example, does an entire school of fish wheel at precisely the same moment and settle on exactly the same course, as though by signal? How can a shark unerringly sense which of its prey is disabled, which is the weakest, which is most afraid?

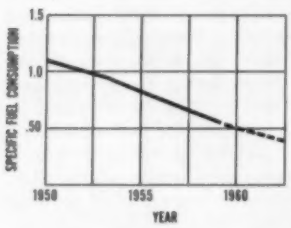
As these secrets are revealed through research and experimentation, we can design new equipment using the same principles. Because of our vital task of antisubmarine warfare, the Navy is directing a concerted effort toward improving our knowledge of the often hostile environment of the seas.—*Given before the American Association of School Administrators, Philadelphia, Pa.*

Small gas turbines soon to surpass piston engines for competitive applications

by Herbert Kunzel, President
Solar Aircraft Company
A Subsidiary of International Harvester Company

The gas turbine engine has made news this year as it has expanded into new and broader applications in the prime mover field. Behind this advance is continuing improvement in design and production. Even more advanced gas turbines will be developed in the next few years. In the small engine class (under 1000 hp) gas turbines will soon surpass overall piston engine performance and cost for competitive applications. They will also retain the inherent advantages of the gas turbine over the reciprocating engine.

One of the major reasons for this prediction is an impressive improvement in gas turbine economy. Previously, fuel consumption and high initial cost have kept the turbine out of all but selected power assignments. Industry and the military both thought the engines too expensive for most applications.



Through constant improvement, however, Solar has been steadily bringing simple cycle, small turbine specific fuel consumption down to an area competitive with piston engines. The fuel consumption of Solar's early 50 hp engines in 1948, for instance, was about 2.25 lb/hp-hr. The 1100 hp Saturn engine, which went into production this year, has the excellent simple-cycle fuel consumption of only .63 lb/hp-hr. Solar's experienced engineers improve life, "producibility," and performance characteristics with each new engine. At the same time, production costs are lowering rapidly.

Another significant advance in Solar turbine development has been the evolution of a unique design philosophy. Most gas turbines fall into one of two extreme categories: 1) Lightweight, high horsepower aircraft turbines, built to be as light as possible (about ¼ to ½ lb/hp), and 2) conventional industrial engines designed along the lines of steam turbines with a ratio of about 10 lb/hp. Both have inherent disadvantages. The aircraft turbines are relatively delicate with consequent problems of frequent overhaul and short life. Massive engine design, on the other hand, involves unnecessary bulk and difficulties with thermal lag and distortion. In either case, inherent advantages of the gas turbine engine are diminished and initial cost is adversely affected.

Solar's approach has been to develop a family of gas turbines that have both long life and light weight. The Saturn engine, with a weight-to-power ratio of 1.1 lb/hp, is heavier and more rugged than aircraft engines but much lighter than the usual industrial gas turbine. Although it is designed for long life, it has no more materials than are necessary to satisfy structural and thermal requirements.

Promising even further improvements in the turbine engine is the combination of Solar with International Harvester Company this year. IH saw the advantage of more power per pound several years ago. Their research and development has stressed performance and much work has been done by them on regenerative cycle turbines to reduce fuel consumption.

To basic research, they have added their many years of experience and leadership in high performance and low cost through efficient production of many thousands of IH engines for trucks, construction equipment and farm machinery.

Solar's successful Saturn engine development team and the combined research and resources of the two firms are now focused on further engine development in the area below 1100 hp. Preliminary design for a turbine in this range indicates that the following standards are feasible:

1. A life cycle equal to or better than conventional diesel engines—with considerably less maintenance.
2. Fuel consumption in the .4 to .5 lb/hr range.
3. Cost competitive to conventional reciprocating engines.
4. Inherent ease of starting and operation in a wide variety of climatic conditions.
5. Small size and light weight.

Developments like these are certain to continue the increase in turbine applications and use.

For additional information write to Dept. J-10, Solar Aircraft Company, San Diego 12, California.

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His switch is compact. It is designed to work in any missile at any range with any payload. It is ingeniously simple in conception, design, and operation. A spring is attached to a free swinging hammer, the spring force acting to pull the hammer against the contact plate. At calibration the spring can be set to oppose any G from 1 to 100. When the missile is launched, the hammer is held back by the acceleration forces until the stage decays to the desired separation G. When the spring force overcomes the forces of acceleration, the hammer comes forward, strikes the contact plate, and the circuit required to make separation is closed automatically. No guesswork, no luck, no *collision*.

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LIEUT. COL. S. M. SMOLENSKY, engineer, Alexandria, Va.

CAPT. J. M. P. WRIGHT, naval ordnance engineer, logistician, editor, Washington, D. C.

The Taste of Courage. Edited by Desmond Flower and James Reeves. New York: Harper & Brothers. 1,120 pp. $10.

THIS book is a compendium of the Second World War—a compilation of records and accounts of that conflict, written by the articulate few from the inarticulate mass. These accounts tell in detail of the experiences and emotions of people during this war—people in uniform and out, people of high and low stature, people fighting and people fleeing, people living and people dying.

The reader shares the responsibilities and the thinking of the VIP's and the leaders, lives again with the fighting man through monotonous waiting and cold-sweat combat, cringes in the wreckage of cities under the crump of bombs, sickens with disgust and horror in genocide prison camps, and in the end reads in the firestorm of the Hiroshima device the promise of a better world, dedicated to the dignity of man.

This anthology is, in effect, a monstrous mosaic. Thousands of shards, differing in color, shape, and size, are fitted together by masters' hands to merge into a single colorful, meaningful picture of the war. This is not history: it is a collection of material with which and from which history is written. And, say the editors hopefully, it offers to the future generations a detailed picture of what may be the last war of its kind.

The historian will use this work as a tool and as a source book, the student of history will get both background and minute detail, while the knowing reader, recognizing it as a great contribution to the literature of war, will find it to be of engrossing interest with a fascination like that of a kaleidoscope.

It is noted with pleasure and in passing that excellent maps, adequate in number and coverage for the broad subject, differentiate this volume from many recent books on not-so-recent wars.—CHARLES MCKNIGHT.

Confederate Strategy from Shiloh to Vicksburg. By Archer Jones. Baton Rouge: Louisiana State University Press. 261 pp. $5.

THIS is a thoughtful evaluation of Southern general strategy during the critical months from April 1862 to July 1863. The

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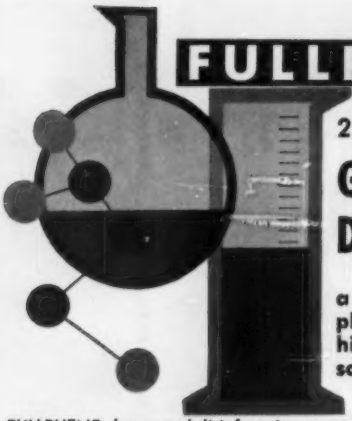

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Book Reviews (Contd.)

author has given much attention to the oft-neglected civil high-command, in particular to Secretaries of War Randolph and Seddon. Considerable new light is cast on the most controversial figure of the Southern government—President Davis.

Readers of Civil War history long have noted how relatively neglected has been the Western fighting. Jones does much to undo this imbalance. The three maps would seem rather scanty but are not entirely inadequate for their purpose. With such a veritable flood of "general-information" books that mark the opening of this Centennial year, it is good to see some quite thorough works appearing.—F. W. FOSTER GLEASON.

Off-The-Road Locomotion. By M. G. Bekker. Ann Arbor: University of Michigan Press. 220 pp. $10.

GREAT improvements in transportation through the air have been made because of studies of aeronautical science, including the parameters of lift and drag. In off-the-road locomotion, similar terms are used in the study of the flotation-traction ratio of a land vehicle.

While many recognized authorities have written much thicker volumes to explain the relationship between the shape of an airplane wing and its air environment, Bekker has condensed into a text of less than 200 pages a reasonable explanation of how soil properties should be considered in connection with the design of a cross-country vehicle, whether it is moved on a continuous track or on wheels.

Based upon the unit power of propulsion required for animal locomotion, the author shows that even though tracked and wheeled vehicles may approach or exceed the efficiency of walking and running on hard smooth ground or paved road, the efficiency of either type of vehicle during locomotion on soft ground falls off significantly while the corresponding effect on animal locomotion is almost negligible.

The increase in motion resistance to the locomotion of a tracked vehicle due to going "off-the-road" raises the power required for propulsion from 7 to 10 horsepower per ton, or by a little over 40 per cent; but for a comparable wheeled vehicle under similar conditions, the increased power requirement would be from 3 to 15 horsepower per ton, or 5 times as much.

These ratios demonstrate the desirability of using a properly designed tracked vehicle for cross-country locomotion and the need for knowledge of terramechanics by engineers concerned with the design of any vehicle.

To quote Bekker, "Future off-the-road vehicles may be as much related to the present ones as an early propeller-driven aircraft is related to a jet." Technological developments in combustion, fuels, and materials have led to great improvements in the current concept of vehicle design. In addition, the "train" concept of coupling together cars of the same weight and size has been used to control the unit pressure under each vehicle.

More consideration must be given to the ratio of length to width and to the shape of vehicular elements that will be in contact with the ground, soil, snow, or both. The form, size, and spacial orientation of the ground-contact surface must be developed to produce maximum thrust-weight ratio and hence the optimum performance in the given environment.

After giving a brief but comprehensive summary of the physical and geometric properties of soil, mud, and snow as they constitute terrain surface the author describes "flotation," pointing out the basic factors that determine flotation and the relationship between flotation and soil conditions. It is demonstrated that the "soil thrust" less "motion resistance" gives the useful force to accelerate the vehicle, climb slopes, or pull loads, called "drawbar pull."

Possible improvements in existing trends of off-the-road vehicle development are suggested and theoretical concepts to ac-

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A.O.A. DIRECTORY AND INDEX

- **The Annual A.O.A. Directory for 1960-1961 is still available. It contains rosters of the national Council, officers and directors, and advisory board of the Association. It also shows the officers and directors of each local A.O.A. Post and the members of the national Technical Divisions and Sections. The Directory also includes the Honor Roll of the Company Members of the Association, and an organization chart of the national society. It is available to A.O.A. members only.**

- **The Index to Volume XLIV of ORDNANCE also is available. It is arranged alphabetically by subject and author with title page for binding and covers issues No. 235 (July-August 1959) to No. 240 (May-June 1960) inclusive. The Index to Volume XLV will be available next month.**

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Book Reviews (Contd.)

complish these improvements are stated. The criteria of "soil trafficability" is defined, and plans for pertinent research are outlined in the last chapter of this highly informative book.—B. S. MESICK.

The Great Sea War. Edited by E. B. Potter and Fleet Adm. Chester W. Nimitz. New York: Prentice-Hall, Inc. 468 pp. $7.95.

PROFESSOR Potter and his writing team backed by Fleet Admiral Nimitz have produced an account of the naval phases of World War II that is correlated expertly with the over-all strategic considerations of the Allied High Command. They have also phased in sufficient background on land actions to give the reader a profound appreciation of the over-all struggle.

The presentation is facilitated by disregarding the chronological order of events in favor of describing the sequence of operations in one area at a time, requiring a minimum of jumping back and forth over the globe. Maps and diagrams are adequate. Numbers and dates must have been kept to a minimum so that the authors could introduce brief comments on the difficult decisions faced by commanders in numerous incidents.

This makes the "The Great Sea War" especially interesting reading and provides a splendid background for anyone who wishes to study the many naval actions that have been covered at length by American, British, German, and Japanese authors.

It is interesting to note that this book was taken almost bodily from "Sea Power" released a few months ago by the same writing team and publisher. For about $7.00 more you can get the history of naval actions and their influence on history since the days of the Phoenicians.—J. M. P. WRIGHT.

Hitler Confronts England. By Rear Adm. Walter Ansel, U.S.N. (Ret.). Durham: Duke University Press. 348 pp. $7.50.

HAD "Operation Sea-lion," the proposed invasion of England, been launched in the summer of 1940 immediately after Dunkerque, almost every chance was on the side of its success, although it is quite certain that the loss of the island would not have brought the British Empire to terms with Hitler.

After Dunkerque there was military equipment in England for only one army division. Aircraft production had not yet been built up sufficiently to replenish daily losses. In July 1940, Churchill proposed the removal of the seat of government to Canada, though he had no intention of doing so without a bitter last-ditch fight for England.

But the expected invasion did not come, and Germany dissipated its air superiority in terror air raids of little military value. The reasons given have been various, but Admiral Ansel has done a superior job of analysis of original German source material to determine the real causes for the failure.

Hitler's otherwise astute mentality lacked natural human morality and did not always produce logic. However, his invasion plan was sound, but he was unequal to the task of overcoming interservice rivalries. His intuition of British "Friedensbericht" told him that England would never submit to terror, but he gave in to Goering's air quackery and swaggering confidence that he could terrorize the English by bombing; moreover he could not bring himself to issue firm orders to the navy whose admirals had an intrinsic fear of British seapower.

But perhaps the greatest cause of Hitler's indecision in launching the attack was his belief that the English would see with him that Soviet Russia was the real enemy of civilization and that peace terms could be arranged with Britain after a show of might. The book should be studied for its lessons in over-all military cooperative planning rather than as a text on operations logistics.—GEORGE S. BRADY. *(Continued on p. 872)*

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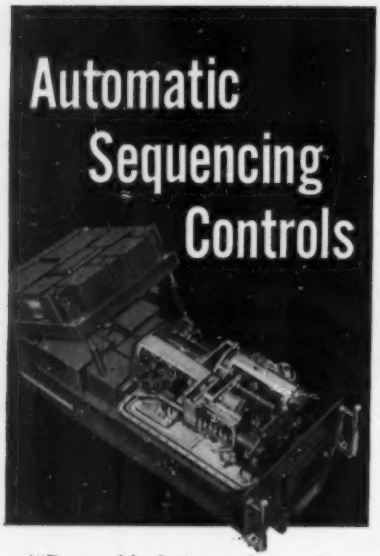

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Book Reviews (Contd.)

Russia's Rockets and Missiles. By Albert Parry. New York: Doubleday & Company. 382 pp. $4.95.

EVER since the orbiting of Russia's Sputnik I in October 1957, we have asked ourselves, "How could this situation develop?" The present volume purports to answer that question.

The author, Dr. Albert Parry, was born in Russia; eventually he joined the faculty of Colgate in 1947 and set up the present program of Russian studies there. He has the advantage of being able to translate Soviet writings directly.

In this volume he traces Soviet rocket progress from the time of the Czars and reviews the details of known Soviet missiles, including their program for submarines with "Polaris-type" weapons. Most interesting, however, is what the Russians say and what we know about their Sputniks, Luniks, and so forth.

Although not much is revealed officially, some accounts have been published in Soviet journals of their man-in-space efforts. Failures apparently have occurred.

"Russia's Rockets and Missiles" is not a highly technical book—it is a most readable account of the Soviet program that will absorb the interest of both the engineer and the layman.—LOREN E. BOLLINGER.

They Fought for the Union. By Francis A. Lord. Harrisburg: Stackpole Company. 375 pp. $12.50.

DR. Lord is an historian of considerable experience. His service with infantry, with cavalry, and finally with Army intelligence has given him a sense of military values not always found in otherwise competent historical writers. He now serves as a member of the Advisory Council of the Civil War Centennial Commission, and here presents a large and handsome volume of the "comprehensive" type.

Of the author's grasp of the great conflict there can be no doubt; he has presented the story of the Union Army in its entirety. However, it seems to this reviewer that as a book designed to inform and appeal to the reader whose knowledge of the Civil War is not too deep, the lack of presentation of "the opposition" may well lead to a failure to picture the Civil War as a living whole.

The documentation is both profuse and excellent. Many photographs are unusual; woodcuts and line drawings are numerous and well chosen. A bibliography is provided.

Ordnancemen will be gratified to note that Dr. Lord has joined the ranks of the newer historians who are more weapons-conscious than their predecessors. A full chapter (20 pages) is devoted to this

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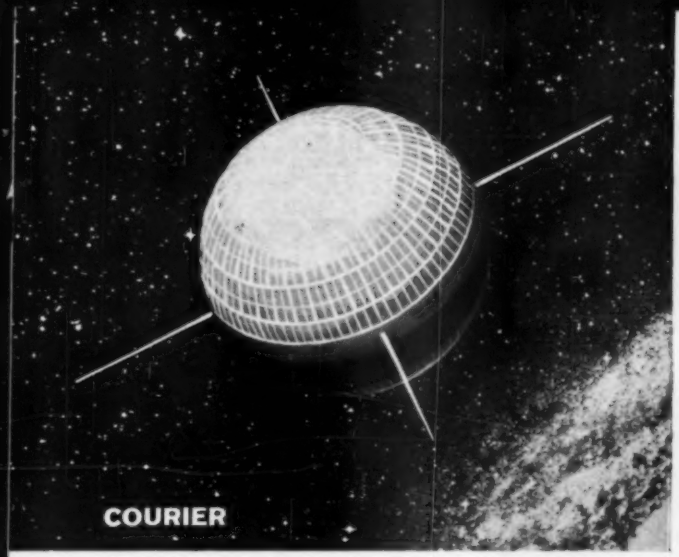

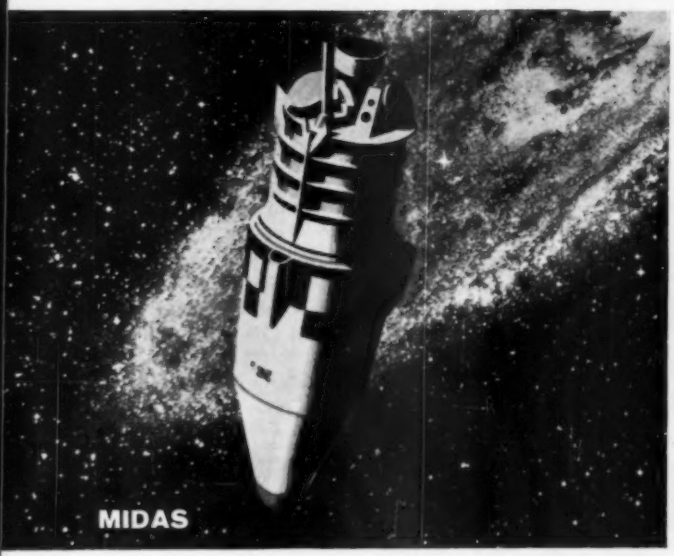

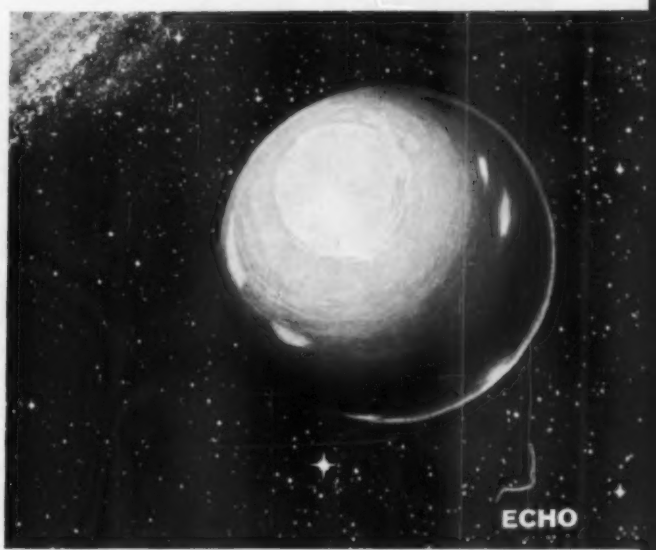

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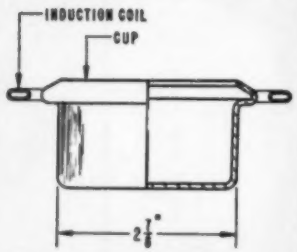

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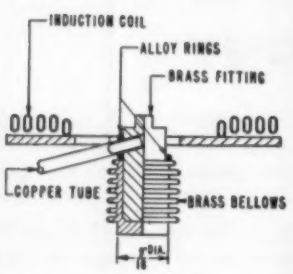

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Book Reviews (Contd.)

subject plus numerous allusions throughout the volume.—F. W. FOSTER GLEASON.

Beyond the Ranges. By Col. Consuelo Andrew Seoane, as told to Robert L. Niemann. New York: Robert Speller & Sons Publishers, Inc. 256 pp. $5.

THE publisher describes the contents as "terse and pungent comments upon events as seen through the eyes of a distinguished soldier." But the book is placed out of the range of military biography by the inclusion of profuse commentary on political and policy matters with which the author really had no direct personal contact. For example, the whole chapter on "Pearl Harbor Downfall" is apparently the ghost writer's views on that event, and it seems largely taken from Admiral Kimmel's book.

Colonel Seoane had an interesting military career from private soldier to staff colonel through a dramatic period beginning with the Spanish-American War. It is unfortunate that he did not write the story himself. Reflecting the events of his life through the pen of a propagandist of the psychological warfare news branch of the United Nations does not give the reader any confidence in the book as a serious volume for military study. It does make, however, an interesting story for pleasant after-dinner armchair reading.—GEORGE S. BRADY.

Polaris! By James Baar and William Howard. New York: Harcourt, Brace and Company. 245 pp. $4.50.

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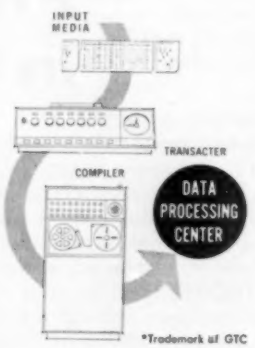

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Book Reviews

BOOKS RECEIVED

Basic Mathematics, Vol. I. By Norman H. Crowhurst. New York: John F. Rider Publisher, Inc. 152 pp. $3.90.

Basic Transistors. By A. Schure. New York: John F. Rider Publisher, Inc. 152 pp. $3.95.

Compendium of Spherical Astronomy. By Simon Newcomb. New York: Dover Publications, Inc. 444 pp. $2.25.

Design Fundamentals of Analog Computer Components. By R. M. Howe. New York: D. Van Nostrand Company. 268 pp. $7.50.

Dictionary of Mechanical Engineering. By Alfred Del Vecchio. New York: Philosophical Library, Inc. 346 pp. $6.

Dynamics of a System of Rigid Bodies, Elementary Part of a Treatise on The. By Edward John Routh. New York: Dover Publications, Inc. 443 pp. $2.35.

Gun Digest Treasury. Edited by John T. Amber. Chicago: Gun Digest Company. 384 pp. $3.95.

Human Factors in Jet and Space Travel. Edited by S. V. Sells and Charles A. Berry. New York: Ronald Press Company. 386 pp. $12.

Illustrated Reloading Handbook. An American Rifleman Reprint. By NRA Editorial Division. Washington: American Rifleman. 224 pp. $4.50 to nonmembers, $3.50 to members.

Introductory Treatise on Dynamical Astronomy, An. By H. C. Plummer. New York: Dover Publications, Inc. 343 pp. $2.35.

Manipulation of Human Behavior. Edited by Albert D. Biderman and Herbert Zimmer. New York: John Wiley & Sons, Inc. 323 pp. $7.95.

Modern Flight Dynamics. By W. Richard Kolk. Edited by C. William Besserer and Floyd E. Nixon. New York: Prentice-Hall, Inc. 288 pp. $7.50.

Photoelasticity Principles and Methods. By H. T. Jessop and F. C. Harris. New York: Dover Publications, Inc. 184 pp. $2.

Physics, the Pioneer Science. Vols. I and II. By Lloyd W. Taylor. New York: Dover Publications, Inc. 395 and 847 pp. respectively. $2 each.

Principles of Stellar Dynamics. By S. Chandraesekhar. New York: Dover Publications, Inc. 313 pp. $2.

Semiconductors and Transistors. By A. Schure. New York: John F. Rider Publisher, Inc. 144 pp. $2.90.

War Planes of the Second World War, Vol. I. By William Green. New York: Hanover House. 192 pp. $2.75.

Weight-Strength Analysis of Aircraft Structures. By F. F. Shanley. New York: Dover Publications, Inc. 404 pp. $2.45.

World's Warships, The. Edited by Raymond V. B. Blackman. New York: Doubleday & Company. 256 pp. $3.95.

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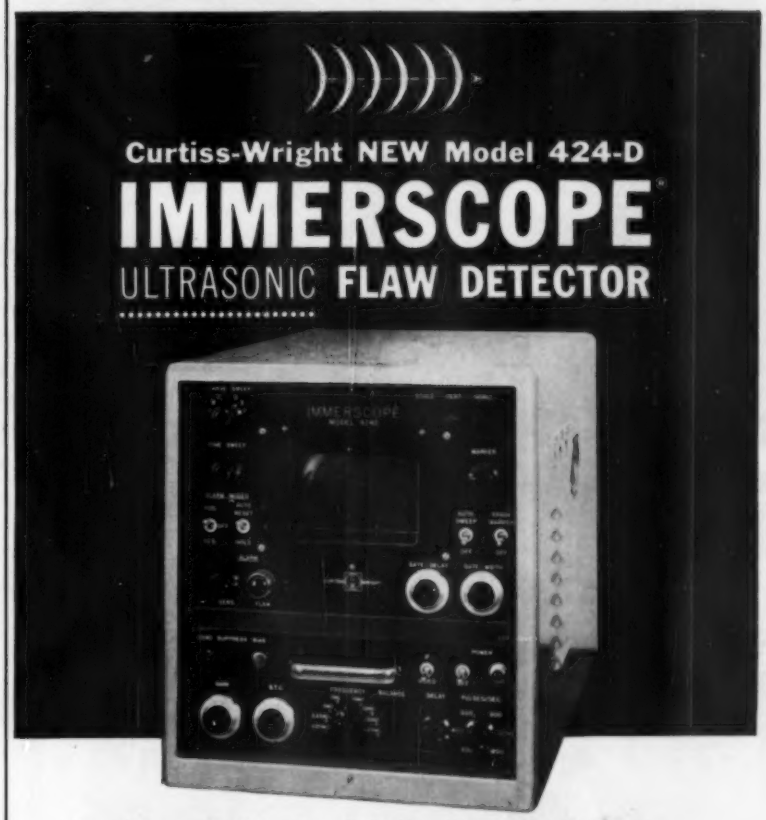

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Armament Technology

This section of ORDNANCE contains selected papers on armament technology presented at meetings of Technical Divisions and Sections of the American Ordnance Association and contemporary articles on armament research, development, manufacture, and field use

Shock-Wave Photography

Reflectorized material makes possible shadowgraph photos in daylight

David McLanahan

DESPITE spectacular advances in modern weapons technology, an explosion-caused shock wave is still one of our major damage-producing mechanisms. A continuing study of shock-wave phenomena is therefore essential for maximum effectiveness of explosive weapons, especially in such applications as missile warheads where delivery costs are extremely high.

A valuable tool for this research is the Scotchlite shadowgraph technique, which allows a camera to photograph shock waves of as little as one-tenth of a pound per square inch overpressure. Originally used in ballistic ranges for missile studies, this technique has now been adapted for field use with high explosives.

SHOCK-WAVE research presents some problems. Moving faster than sound, a shock is difficult to "stop," and once "stopped," being primarily an abrupt change of density, it is difficult to see. It can be destructive of equipment used to study it if proper precautions are not taken, and there is always a question whether the measuring or recording apparatus is affecting appreciably that which is being measured.

Photographic methods have been used for some time, generally employing high-speed cameras. Particularly striking photographs have been published of nuclear explosions, but ordinary photographic techniques will render the shock front visible only above one p.s.i. overpressure. As damage to structures begins well below one p.s.i. overpressure, this leaves a considerable gap in the photographic data.

Of course, in the laboratory it has been possible to record low-pressure shocks by several methods. Simplest of these to set up is the shadowgraph. One form of this technique requires only a sheet of film and a short-duration point source of light on opposite sides of the phenomenon.

The slightest ambient light, however, either from the phenomenon itself or from the surroundings, will fog the film and spoil the record. Several modifications of this principle use cameras, greatly reducing the effect of ambient light, but restrictions on the available light sources have prevented their use in full daylight.

FIRST used by Dr. Harold Edgerton at Massachusetts Institute of Technology, and pioneered by Dr. Donald R. Grine at Stanford Research Institute and the author at the Naval Ordnance Laboratory, the Scotchlite technique has photographed shock waves of less than one-tenth p.s.i. in daylight under field conditions.

While many adaptations of the basic idea have been used, much of the work has been done with a conventional Eastman high-speed camera using an ordinary flashbulb for the light source.

The key to the system lies in the properties of the Minnesota Mining and Manufacturing Company's Scotchlite,

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long used to "reflectorize" automobile bumpers and roadside signs. Designed to return as much light as possible back toward the source, this material acts in two related ways to make the daylight shadowgraph work. First, if a light source is placed near a camera, the Scotchlite will return 200 to 600 times as much light as white paint similarly placed would. Secondly, light falling on the Scotchlite screen from other sources is returned primarily toward these sources, rather than into the lens where it would detract from the quality of the record.

The actual practice of this work is as simple as the explanation. The reflective material may be applied to any flat surface either as a paint or as adhesive coated sheets. A high-speed camera is then focused on this surface from an appropriate distance for the experiment.

THE camera's optical axis should be within twenty degrees of perpendicular to the surface unless reference marks on the Scotchlite surface impose more stringent requirements. The charge can be located one-half to two-thirds of the way from the camera to the screen either in the field of view or to one side, depending on the region of interest.

An ordinary flashbulb will suffice for the light source. The new zirconium lamps (M-2, M-5, etc.) act as a point to the system beyond about 30 feet, the Press 25 bulb from about 50 feet, and a No. 2 or No. 3 from 70 to 80 feet. The lamp may be enclosed in a short tube of aluminum foil, but should not be used in a reflector which will increase the effective diameter. The bulb placement is the most critical part of the setup, and optimum results require some prior qualitative knowledge of the shock to be photographed.

The bulb should be placed at the camera location with its center displaced from the lens about an inch for every ten feet of camera-to-charge distance, along a line parallel to the direction of shock-wave propagation and on the side toward the charge. (A shock front is perpendicular to its line of propagation.)

The reason behind this placement of the light source is evident from Figure 2. As the light approaches the lens, less of the shadow is visible through the undisturbed medium and more is viewed through the shock, tending to cancel out the image. The finite size of the lens will prevent complete cancellation, but the image will suffer.

Placement of the source further from the lens will allow the camera a better view of the shadow, but the narrow returning cone of light from the Scotchlite will miss the lens, and the effect of the Scotchlite will be lost.

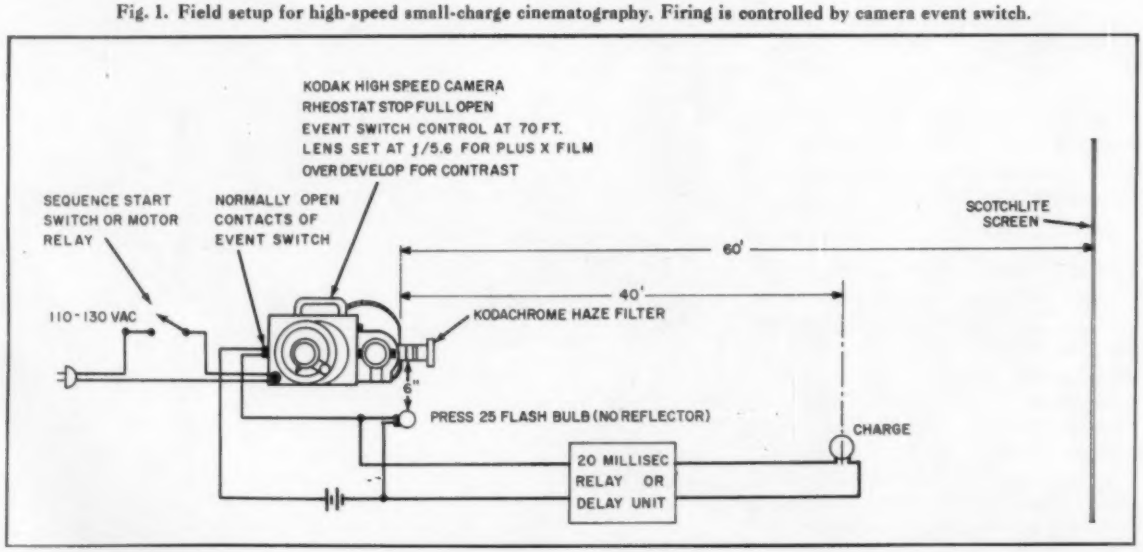
For the shots shown in Figure 3, an Eastman high-speed camera was used with an M-2 bulb 60 feet from the screen as shown in Figure 1. The camera was running at about 3,300 pictures a second at f/5.6 with Plus-X film. The flashbulb was fired by the camera synchronization switch. A delay unit then fired the charge twenty milliseconds later when the bulb had reached its peak.

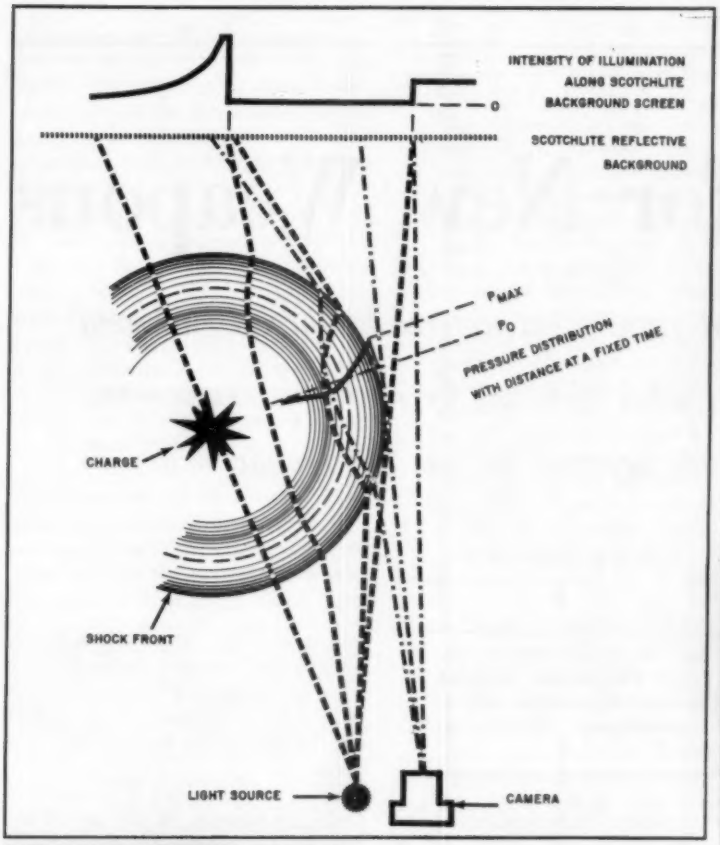
This technique also is applicable to larger charge work where it is desired to see only a small portion of the shock wave or the interaction of such a portion with a body or another shock. Figure 4 shows such a record from a 10,000-pound charge.

UNFORTUNATELY, as the shock radius becomes much larger, obtaining a record of the primary wave becomes more difficult until an infinite radius (or plane wave) is reached, and the mathematical probability of obtaining any primary shock record becomes negligible. This deficiency, however, applies to any system of shadowgraph.

The net result is that the technique of shadow, long used under controlled laboratory conditions, can now be used in the field with only minor modification to the standard equipment to be found in most research photographic departments. The photographic records resulting will give not only a good qualitative picture of the event, and the shape and relative placement of shock waves, but under favorable conditions will yield approximate pressure levels, either through the shock velocity or through the width of the shock wave image on the film. Thus this technique is a valuable tool to add to the ever-expanding "bag of tricks" the explosives physicist has at his disposal.

Fig. 1. Field setup for high-speed small-charge cinematography. Firing is controlled by camera event switch.





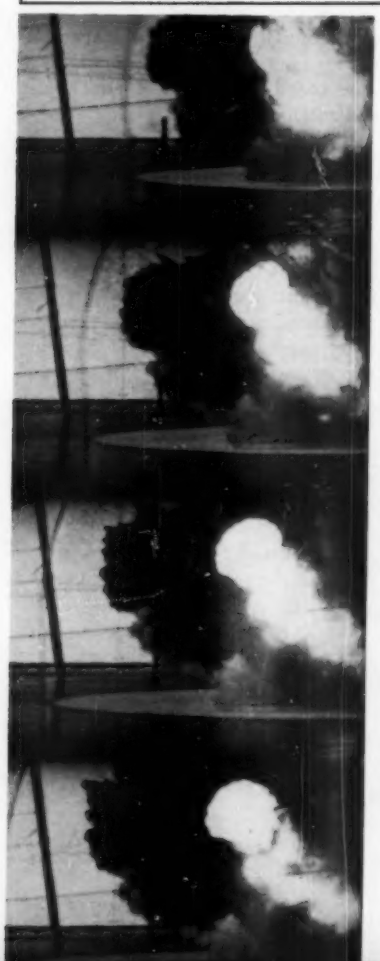
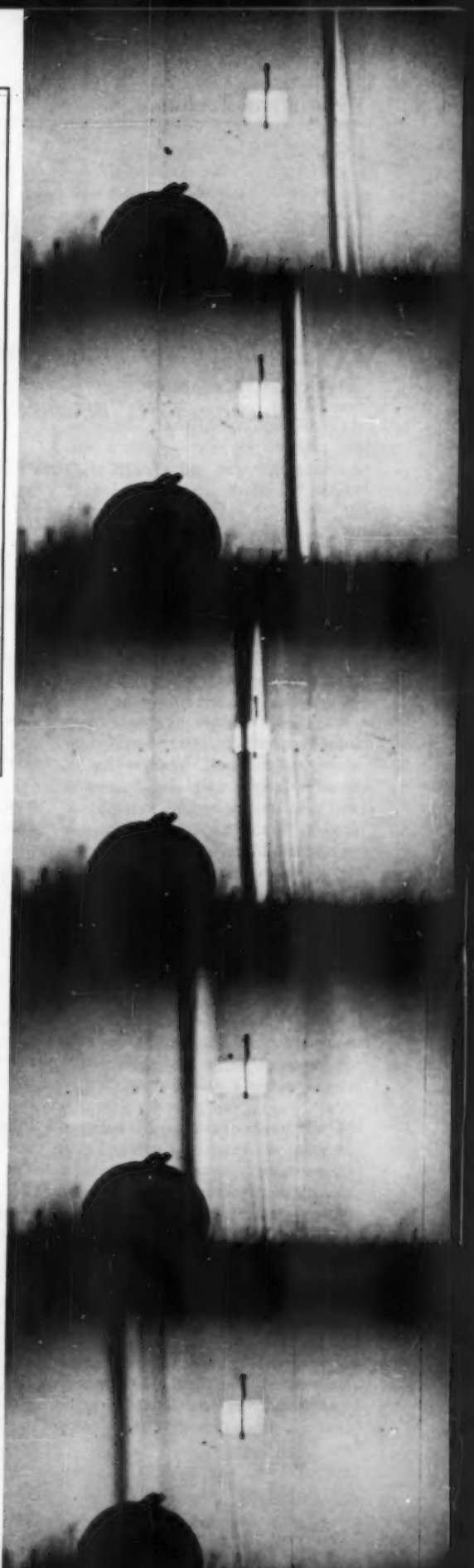


Fig. 2, above, ray paths in reflected shadowgraphy. Light from source at bottom passes through shock envelope and is refracted as a function of the angle of incidence and change in density in the shock. After striking reflective screen it is reflected back through shock wave where it is seen by camera as a dark strip followed by a white band. Fig. 3, left, high-speed sequence of charge fired in water. A one-pound sphere was hung half in water on right side of frame. Kodak high-speed camera ran at 3,300 pictures per second. Considerable turbulence is evident behind shock in first frame; secondary shock has formed Mach stem which can be seen in subsequent frames. Fig. 4, right, high-speed sequence of large-charge shock wave. A 10,000-pound charge was laid on ground 325 feet to right of frame. Reflecting screen was 71 feet from camera. Shock wave is seen moving from right to left.



Ceramics for New Weapons

The high operating temperatures encountered by the internal and external parts of our guided missiles, by electronic components, and by nuclear devices all demand the use of ceramic materials

Albert P. Levitt

Mr. Levitt is chief of the High Temperature Materials Branch, Watertown Arsenal Laboratories, Watertown, Mass.

CERAMICS may be defined as refractory, inorganic, nonmetallic materials whose manufacture requires the use of high temperatures. The working of ceramics is as old as civilization itself. Among the materials which are considered to be ceramics are clays, glasses, and refractory oxides. Some investigators also classify graphite and the carbides, borides, nitrides, and silicides of the refractory hard metals as ceramics.

All are familiar with the civilian uses of ceramics as white ware, porcelain, and pottery. In these forms they play a virtually indispensable role in maintaining our high standard of living.

Ceramics also play an extremely important role in modern weapon systems and in the future they may be the only materials capable of meeting the rigid design requirements for high-temperature service in advanced weapons.

THE accelerating drive toward operating weapon systems at ever higher temperatures continues unabated because of the significant improvements in thermal efficiency and weapon effectiveness that can be so obtained. In rockets and guided missiles, high temperatures are produced internally by the very hot exhaust gases of the rocket engine and externally by severe aerodynamic heating.

Relatively high temperatures also are encountered in electronic components such as radomes, tubes, transistors, and resistors. High temperatures likewise must be resisted in nuclear devices and the more conventional weapons such as mortars, antitank and antipersonnel guns as well as in tank and automotive engines.

In all these cases, the development of new and improved weapons will increasingly depend on the availability of suitable heat-resistant materials. Unfortunately, as operating temperatures increase, the number of such materials will tend to decrease.

As the limits of most engineering metals are now being reached or exceeded, interest has grown in ceramics because of their relatively attractive high-temperature properties such as high melting point and high chemical stability.

IT should be emphasized however, that although melting point is a useful criterion in selecting a ceramic for high-temperature service, it also must be selected on the basis of its chemical compatibility with its environment. In many cases the current deficiencies of ceramics can be overcome by the use of composite structures or ingenious designs.

The application of ceramics to weapons is very broad and may be divided into three major categories: structural, thermal insulation, and electronic. Since space limitations preclude a discussion of all these applications, this discussion will be confined to the first two categories.

Current applications of ceramics to Ordnance weapons include the following: Rocket nozzles (as throat insert or coatings), combustion-chamber liners, metevators, missile radomes, missile nose cones, and missile control vanes and surfaces.

IN all these applications, ceramics are used because they have unique properties which make them unusually well suited for the job. For rocket-nozzle applications they possess the high melting points, chemical stability, erosion resistance, and low thermal conductivity necessary to withstand the high-temperature, high-velocity, erosive and corrosive exhaust gases. The same properties make them useful for the other applications mentioned above. As missile radomes, ceramics have the additional advantage of being transparent to radar signals.

If we consider the word "weaponry" to mean the science of developing and producing weapons, then the role of ceramics in metals processing and fabrication should not be overlooked. Here, too, these remarkable materials are invaluable. In metals processing, ceramic crucibles provide the means for containing, melting, and pouring metals. They also provide the molds for casting

metals. Ceramic cutting tools, which were pioneered at Watertown Arsenal, speed up the machining of hard metals because of their extreme hardness and heat resistance.

In order to meet the growing need for new and improved materials for high-temperature service in Ordnance weapon systems, the Watertown Arsenal Laboratories have embarked on a broad high-temperature materials research program. A major portion of this program is devoted to ceramic research, the salient features of which are described below:

1. *Determination of Thermal Properties of Ceramics at Elevated Temperatures.*—There is a marked lack of reliable data on the very high temperature properties of many ceramic materials. Such data are essential for the rational use of these materials in high-temperature designs. At the present time, studies are directed at measuring the thermal conductivity of selected refractory materials at temperatures up to 5,000 degrees Fahrenheit. A special thermal conductivity apparatus has been constructed with this capability. The total normal and spectral emissivity of spectral graphite have been measured up to 5,000 degrees Fahrenheit.

Determination of Mechanical Properties of Ceramics at Elevated Temperatures.—Accurate data on the high-temperature mechanical properties of ceramics must also be known for proper design of high-temperature ceramic structures. Because of the brittle nature of these materials, special techniques and apparatus must be devised to obtain reliable data. Current studies are aimed at measuring the high-temperature elastic constants and tensile strengths of selected ceramics.

Development of Improved Ceramics and Cermets.—In the ceramics area, research is directed at improving and controlling the processing variables (such as purity, composition, particle size, and heat treatment) to produce superior high-strength ceramics. It appears that the properties of present-day ceramics can be improved by an order of magnitude by precise control of purity, microstructure, and elimination of porosity in these materials.

In the cermet area, the ZrO-Ti system is being investigated. Initially, the objective is to develop a strong chemical bond between the metal and ceramic. This will be approached through solid-solution formation during sintering, either direct or in situ. It is hoped that this work will yield a cermet having improved impact and thermal-shock resistance.

"As the limits of most engineering metals are now being reached or exceeded, interest has grown in ceramics because of their relatively attractive high-temperature properties such as high melting point and high chemical stability. It should be emphasized, however, that although melting point is a useful criterion in selecting a ceramic for high-temperature service, it also must be selected on the basis of its chemical compatibility with its environment. In many cases the current deficiencies of ceramics can be overcome by the use of composite structures or ingenious designs."

Development of New and Improved Plastic-Ceramic Materials.—Reenforcement of plastics by refractory ceramic fibers should yield a class of materials having very high strength-density ratios, and high-temperature resistance, which can be molded into complex shapes with close tolerances.

Plastics such as epoxy resins, polyesters, silicones, and phenolics, will be reenforced with ceramic fibers such as graphite, quartz, asbestos, high-silicon glass, zirconia, potassium titanate, and alumina. In all cases the effects of fiber length and diameter, resin to fiber percentage, and fiber orientation will be investigated.

Flame-Sprayed Ceramic Coatings.—The ability of flame-sprayed ceramic coatings to protect metals from high-temperature corrosive gases has already been demonstrated. Current research is aimed at: (a) improving the coating properties by optimizing the variables involved in the coating processes; (b) developing improved coating compositions; (c) adapting these coatings to the solution of high-temperature problems in ordnance and in metals processing.

To date, these coatings have been successfully applied to experimental components of the Davy Crockett system, such as cap ends, rocket nozzles, and rocket motor bodies, and to mortar components. Alumina coatings were also applied to the iron molds used for casting titanium. In this application, the coating prevents contamination.

A plasma-spray unit also has recently been acquired. Since this device generates temperatures up to 30,000 degrees Fahrenheit, it can readily melt any known material and can easily apply refractory ceramics (borides and carbides) whose melting points are higher than the temperature of an oxy-acetylene flame.

Graphite Development.—Graphite is a most attractive material for high-temperature service because of its very high melting point, low density, machinability, low cost, and ready availability. Unlike other materials, its mechanical strength increases with temperature up to about 4,500 degrees Fahrenheit. On the other hand, its tensile strength is relatively low and it readily oxidizes. However, its advantages far outweigh its disadvantages and current studies are directed at:

1. A systematic analysis of the processing variables to determine their effect on the properties of the resulting graphites.

2. The measurement and correlation of crystalline parameters, grain orientation, density, homogeneity, mechanical strength, and oxidation resistance. This study has been facilitated by the development of a novel technique for the microstructural analysis of graphite using catholdic etching. By means of this technique the true structure of graphite has been revealed, and with it a better and more complete understanding of this complex material.

Research in progress indicates that while a "ductile" ceramic is not currently available for practical applications, remarkable improvement in the properties of these important materials can be achieved by precise control of their composition, purity, and fabrication processes.

As the operating temperatures of weapons systems trend higher, we will of necessity come to depend increasingly on ceramics for solving high-temperature materials problems.

Supersonic Target Drones

The advent of high-performance missiles makes defense against them imperative, and the liquid-fueled ramjet-powered drone is well suited to offer an economical target to our defensive antimissile weapons

T. L. Trexler

FROM the beginnings of weapon technology, as primitive as it was in primeval times, the race between offensive and defensive arms taxed the ingenuity and inventiveness of all who engaged in the art of war. There were periods when the implements of the offense were superior. At other times defensive devices were developed that provided an insurmountable degree of impregnability. At least one fact is clear, at no time was there ever a perfect balance between the two.

Usually, however, if one searches through history, one finds that the defense has nearly always lagged behind the offense in the development of arms that are peculiar to either element of strategy. It is also interesting to note that as man's technology and understanding of science advanced, as engineering skills were developed, as the kinds of things came about that brought on the invention of the telescope and the printing press, such things were immediately applied to the development of better offensive weapons.

MAN then got around to using such knowledge and skills for defensive purposes only when he began to worry what he would do if attacked with offensive weaponry of the same order which he had just brought into being.

Never, it would appear, has this been truer than today. The state of the art in nearly every field of science and technology is advancing at an ever-increasing pace. These advances when applied to the art of war find most immediate and fruitful application in the field of offensive warfare. The problems, therefore, that confront the defensive planners have become all the more complex and acute.

Mr. Trexler is with the Lockheed Missile and Space Division, Sunnyvale, Calif. This article is taken from a paper presented by Mr. Trexler before a recent meeting of the A.O.A. Guided Missile and Astronautics Division. C. E. Johnson and A. M. Nowitsky, also of the Lockheed Missile and Space Division, assisted Mr. Trexler in the preparation of his paper.

Were it not for the fact that development of defensive weapons is outstripped by offensive advancement, the problem would be much simpler. But because of this fact and the many forms that offensive warfare can take, the problem in some cases is all but impossible to solve. Great technological advancement has brought about the atomic warhead, the hydrogen bomb, and the intercontinental ballistic missile. Against these, what defense is there?

Four or five years ago the problem of defending against supersonic machines seemed fraught with complexity. And the higher the Mach number the more complex the problem appeared. One of the essential tools, if not the most essential, in the solution of this problem was the high-performance supersonic drone used as a weapons systems evaluation vehicle, or as some term it, a verification vehicle.

Essentially, an offensive weapon is used for the delivery of a lethal agent against a static target; *i.e.*, to breach a wall, reduce a trench system or fortification, or eliminate the industrial capability of a nation. Generally the target is sitting still.

The analysis or evaluation of an offensive weapon, providing it works, is then a matter of determining how close it can come to a spot on the map. Whether the range be 500 meters or 8,000 kilometers this miss-distance is easily measurable.

ON the other hand, the target for a defensive weapon is generally moving: A man on horseback, a battleship, a bombing aircraft, or one of the several present-day missiles. The problem begins to complicate itself since it now involves tracking and prediction, which, of course, is a function of time. The problem is complicated even further when the target is able to move through three dimensions.

Finally, as the fourth dimension, time, begins to contract so as to become excruciatingly short, the problem has reached a state of complexity not heretofore encountered.

The question of "how well does the defensive weapon perform?" is the stickler. How difficult it becomes is a function of how many dimensions are involved. In the area of air defense the

problem has been acute, but because of the timely use of high supersonic drones for weapons analysis the problem has resolved into its several parts each readily solvable at a cost which is relatively small.

It is obvious that any test system cannot be compromised to fit the test subject. However, when it comes to testing air-defense weapons within the environment in which they are supposed to operate, such compromises are found to exist. These compromises are justified on the immediate economic grounds of so-called technological expediency.

The compromise exists in the form of testing Mach 2-plus air-defense weapons against aircraft of World War II vintage because these can be made into targets at low cost. This does not constitute today's threat. Our armed forces now have operational a cruise-type air-to-surface missile capable of speeds in excess of Mach 2. We must assume any potential aggressor is at least as good as this; therefore, this constitutes a logical threat.

WHAT do we learn when we fire against subsonic targets? We learn that against QB-17's and QF-80's we're pretty good. We have had a supersonic target drone since 1956 capable of speeds up to Mach 3 and altitudes to 80,000 feet. It also is recoverable, thereby providing reflight capability. The Army has used it operationally since mid-1958. It is called the Kingfisher and to date a number of flights have been made against Army air-defense weapons such as the Nike Hercules and the Hawk. The results have been most interesting.

These flights have been conducted under what essentially are laboratory conditions where all elements of the test are carefully controlled. Only by such testing can it be determined that the weapon system under development is indeed reaching those performance milestones laid out by the qualitative military characteristics.

Testing of this nature should and does provide guidance as to what needs to be done in order to achieve these objectives. It also serves to eliminate avenues of development that might appear to be profitable, but which in reality turn out to be fruitless. Finally, areas of operational improvement are defined.

Such a drone must supply some answers. The primary one is precise information as to the miss-distance and trajectory as well as the position of the attacking missile in relation to the target at intercept. This is achieved through use of a firing-error indicator which is essentially a highly specialized radar. Another requirement is target area augmentation of radar reflectivity enhancement which will provide the acquisition and tracking radars with measurable and variable electromagnetic reflection for test purposes.

The performance of the drone must be equal to, if not better than, that of the defense weapon under test. The weapon must be exercised to the very limit of its performance in speed and altitude as well as extremes in maneuverability.

Hence, in a verification drone, sophistication is needed to make it the equal of any interceptor weapon. Such performance places a premium on the propulsion system being used.

The high-speed target drone offers a difficult field for choosing a power plant. Considering all the various facets, the ramjet is a relatively inexpensive and highly reliable power plant for target vehicles where durations of at least seven or eight minutes are required. For the speed range of Mach 0.9 to Mach 2.5, the normal shock ramjet is a good compromise. In the speed range of Mach 2.0 and over, the spike inlet or isentropic inlet must be used to obtain satisfactory performance.

The efficiency of the ramjet is only 3 per cent at speeds of Mach 0.8. However, the efficiency increases to about 25 per cent at Mach 2.0 and to 50 per cent at Mach 4.0. This latter efficiency ex-

Table A. Comparison of various aerial target propulsion systems.

*System**	*Comparison Category*	*Rating Compared with Liquid-Fueled Ramjet Systems*			*Factors*
		Inferior	*Equal*	*Superior*	
Turbojet	Performance	—	X	—	High cost
	Reliability	—	X	—	
	LMSD Experience	X	—	—	
	Cost	X	—	—	
Air-Turbo Rocket	Performance	—	X	—	In early development
	Reliability	X	—	—	
	Lockheed Target Experience	X	—	—	
	Cost	X	—	—	
Solid-Fuel Ramjet	Performance	X	—	—	In early development
	Reliability	—	X	—	Insufficient fuel control.
	LMSD Experience	X	—	—	Indefinite performance
	Cost	X	—	—	Reproducibility Separate booster/sustainer combination required for each mission —no reflight capability
Solid-Fuel Rocket	Performance	X	—	—	Insufficient endurance for reasonable weight.
	Reliability	—	—	X	
	LMSD Experience	X	—	—	
	Cost	X	—	—	Separate booster/sustainer combination required for each mission. No reflight capability
Ducted Rocket	Performance	—	X	—	Insufficient flight experience
	Reliability	X	—	—	In early development stage
	LMSD Experience	X	—	—	
	Cost	—	X	—	
Liquid-Propellant Rocket	Performance	—	X	—	Separate booster/sustainer combination required for each mission
	Reliability	—	X	—	
	LMSD Experience	X	—	—	
	Cost	X	—	—	

* *"System" includes booster for required and desired missions*

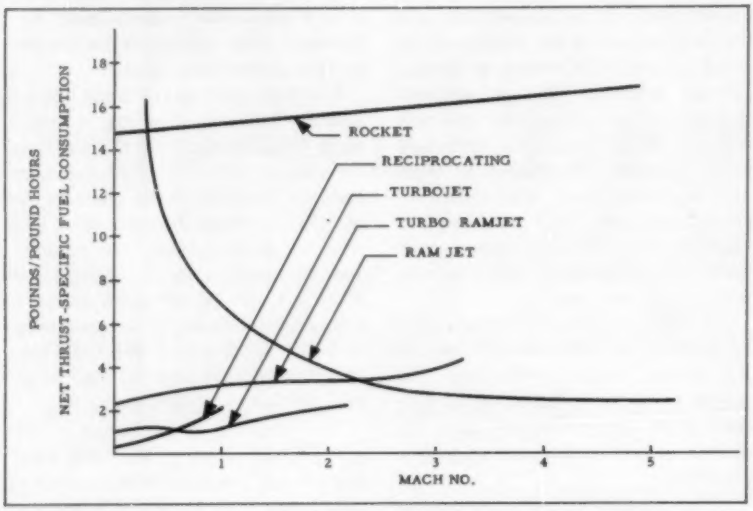


Fig. 1. Engine types and capabilities measured at various Mach numbers.

ceeds those of all other stationary or airborne power plants using hydrocarbon fuel. Figure 1 illustrates what this means in terms of net thrust specific fuel consumption versus Mach number and compares it with other types of power plant.

The fact that the ramjet is not particularly efficient at speeds below Mach 2.0 does not necessarily mean that it should not be considered for this condition. The low drag of the normal shock ramjet provides optimum performance in the transsonic and low supersonic speed range.

Another excellent area for the ramjet is where boost to a relatively high altitude is required. Considerable over-all savings in cost and weight can be achieved by using the more efficient air-breathing ramjet for the climb portion of the trajectory over the use of booster rockets.

AS noted previously, the ramjet offers good possibilities for high-speed target drones, as the efficiency will continue to climb with increased speed. However, the upper limit today is approximately Mach 5, due primarily to structural limitations of materials at the high temperatures encountered in the supersonic speed range. Great strides are being made in developing light-weight materials with high strength at elevated temperatures so that the upper limit is continually being expanded.

On the other hand we must not think of ramjets as solving all propulsion problems for high-speed targets. The ramjets we are using are designed and built for a specific Mach number, and performance drops off appreciably when operated off the design point. This can be offset to some extent by variable-geometry inlets, variable-throat exit nozzles and shock positioners.

These items, while practical, do increase the costs and complexity of the propulsion system so that we are starting to diverge somewhat from our original ground rules of an extremely reliable target at lowest cost. To achieve our original goal we must try and keep the propulsion systems as close to the ramjet "stovepipe" configuration as possible. Recovery and reuse reliability are greatly reduced by each small change in complexity.

The users of targets must, therefore, bear in mind that maximum reliability and lowest cost will only be achieved by specifying the minimum variation in mission requirements. A target drone, if designed to perform all possible combinations of missions, will be degraded in performance to the point where it may not really be satisfactory for any mission. Each offensive weapon must be considered as being different, and the counterpart drone should have flight capabilities parallel to the potential threat.

Many combinations of sustainer and boost power plants have been studied to provide the maximum amount of utilization in an effort to solve such problems. These combinations have taken many forms, such as using a large solid rocket in tandem with the airframe to gain main power plant take-over speed. A more efficient approach is the current use of two smaller solid rockets attached one on each side of the fuselage under the wing.

While the booster mechanism for underwing installation is more complex than the simple ejection system for a tandem booster, the over-all cost is lowered, primarily because the tandem-boost arrangement requires the use of a booster airframe of substantial size in order to assure system aerodynamic stability during the boost phase.

Further, studies conducted to determine the effective use of rocket propulsion alone show that in the area of performance where highest utilization of the drone system can be anticipated, the practical aspects mitigate against this form of propulsion. Primarily, much greater endurance is required than any currently designed rocket can provide, and size and weight penalties are generally too severe.

Therefore, in contemplating any kind of performance range—say between Mach 4.5 to Mach 6.0—the ramjet-rocket combination appears to be best and, as stated above, if one specific point is desired, say Mach 5.0, the results are even better.

HIGH reliability and minimum cost are the primary considerations when selecting the propulsion system for a target drone. In addition, the unit should have the ability to accelerate, climb, and maneuver the vehicle from various take-over Mach numbers and altitudes to any required mission cruise program and have sufficient endurance for a programmed route, if it is to be a useful tool for training and evaluation.

Up to rather high subsonic speeds, the reciprocating engine-propeller combination is entirely satisfactory for propelling aerial targets. However, with speed requirements increasing, the combination proved unsatisfactory because propeller thrust diminishes rapidly after a certain speed is reached, necessitating extremely large and expensive engines for sufficient power. Also, when approaching the speed of sound, shock waves form on the propeller and markedly reduce thrust.

It is necessary at this point to rely on jet propulsion to supply aerial target power needs for high subsonic and supersonic flight speeds.

Jet propulsion devices can be divided into two outstanding categories: air-breathing and nonair-breathing.

In general, the air-breathers result in the greater endurance for a given size and weight, but can be more complicated and higher in cost than systems which carry their oxidizer with them, such as liquid and solid-propellant rockets.

In order to establish the best jet-propulsion system for use of a given set of supersonic target requirements, four basic issues must be considered, as follows: (1) To what extent are the target-performance requirements met when utilizing the system? (2) How does the reliability compare with other systems? (3) What experience has the company had with the system usage? (4) How does cost compare with other systems?

IT is the opinion of Lockheed Aircraft Corporation that the liquid-fueled ramjet appears to offer the best solution to the over-all aerial target propulsion problem for the following reasons:

1. Use of a ramjet results in the lightest weight target system to fulfill all mission endurance and maneuver requirements.

2. Lockheed experience with the manufacture and flight direction of ramjet-powered vehicles includes many successful flights throughout the normal supersonic Mach number ranges.

3. The ramjet acceleration and climb potential is utilized for an air-breathing boost phase, minimizing the solid-fuel rocket booster requirement.

4. The ramjet air-induction system (inlet configuration) can be tailored to fit the desired mission Mach number and altitude range.

5. A ramjet is ideal for recovery and reflight, having no moving parts to complicate restoration procedures.

Table A gives a comparison of other aerial target propulsion systems which bear serious consideration.

With regard to liquid ramjet fuel, selection depends upon required system weight for a given performance requirement. For example, standard hydrocarbon fuels are suitable if weight and endurance are not critical, while pyrophoric or high-energy fuels notably reduce the propulsion system (and consequently the target) weight, since their higher flame speeds yield smaller required combuster lengths.

Obviously a future use of the high-performance drone would be the evaluation of advanced-type interceptor or air-defense weapons. Even after the appearance of the antimissile missile, such as the Nike Zeus, significant results can be achieved by proper evaluation within the environment and performance regime of the weapon. It might not be necessary to employ a ballistics device for such evaluation.

Simulation of reentry, at least in the final stages, might be attainable with a hypersonic air breather flying essentially a ballistic trajectory from some altitude above 100,000 feet. At least, considerable preliminary data should be developed which would prove most helpful in deciding when a very costly ballistics target is feasible. One of the problems not touched on in this paper is training in the use of weapons system. Training in the current class of air-defense systems is being carried out and does not offer too great a problem. Training in an antiballistics weapon is something else. While there is really no technical obstacle, the paramount fact is one of economy. The cost of a Zeus-type weapon is such that training using live rounds is prohibitive.

The answer may lie in a subcaliber approach in which all the elements of the system, as well as the target, are scaled down. This, however, would not preclude the use of a hypersonic drone simulating the approaching ballistics missile. In a model used for training, exceptionally high closing speeds would be necessary for the training to be effective.

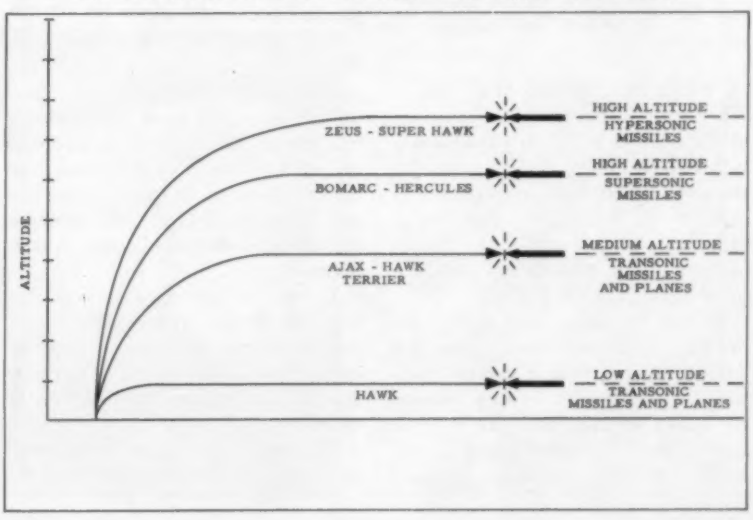
Hypersonic drones have other potential uses. The supersonic transport will become a reality, but before that time considerable research must be carried out in the field of aerodynamics, propulsion, thermal stress, and structural areas. A flying wind tunnel capable of high Mach, perhaps up to 6 or better, would do much to advance the state of the art and greatly ease the problems of supersonic transport design.

One unique application that might be worth consideration is the use of a recoverable hypersonic drone for the first stage of some kind of drone-rocket combination as a sounding device or probe. Such a combination might even be used to put a modest payload into a low orbit. The attractive part of this proposition is in the recovery of the first stage and its reuse with essentially no additional expense except refueling.

IT must be pointed out that the recovery aspects of drone operation have been particularly significant. Reuse of the vehicle in any mission makes the economic advantage obvious. Hence any application of testing in which the recovery of test articles is necessary makes the drone a useful tool, especially if environmental testing at extremely high speeds and altitudes is required.

Propulsion development under way or currently envisioned makes the attainment of hypersonic speeds and ultrahigh altitudes attainable within the relatively near future.

Fig. 2. Comparison of various air defense weapon types now available.



New Alloy Aids Missiles

A specially developed coating to protect the molybdenum probes of guided weapons from the oxidation effects of extreme heat during flight contains a complex combination of chromium and other metals

Arnold I. Sprinz and R. L. Wachtell

BY means of a diffusion-alloy process, engineers at the U. S. Army's Picatinny Arsenal, Dover, N. J., have solved a serious oxidation and metal-erosion problem on molybdenum-alloy probes for guided missiles. Formerly, unprotected molybdenum probes began to oxidize when exposed to airstream temperatures of 1,400 degrees Fahrenheit and above, a condition that became progressively worse as heat increased.

After testing various metal coatings, Picatinny engineers selected Chromalloy Corporation's W-2 surface alloy to counteract the extreme oxidation effects during high-speed flight. This protective alloy, containing a complex of chromium and other metals, was developed specifically for molybdenum and diffuses right into the surface of the probe.

AFTER chromallizing to a depth of 2 mils, probes have been subjected to temperatures as high as 3,850 Fahrenheit without failing. Besides protecting the probe against high temperatures induced by air friction, the alloy also reduces the heat-transfer rate, thereby holding down equilibrium temperatures throughout the probe.

Because the probe must operate under such severe conditions, design was difficult. Probes have a twofold function: (1) to furnish velocity pressure for eleven settings, and (2) to sense static pressure to initiate system fuzing.

The velocity pressure, obtained through the probe's hollow core, is used in the missile guidance system to prevent maneuvers that would cause excessive G-loads; static pressure, which yields an altitude reference, arms the missile.

Mr. Sprinz is a mechanical engineer at Picatinny Arsenal, Dover, N. J. Mr. Wachtell is vice-president of the Chromalloy Corporation, New York, N. Y.

Heating due to airstream friction is directly related to the probe's profile. In turn, the aerodynamic profile controls the probe's pressure-sensing efficiency. Nonuniform airstream flow might cause erratic flight or yield inaccurate static pressure measurements.

After a series of wind-tunnel tests, Picatinny engineers decided on a probe 14.029 inches long with a 7/8-inch outside diameter, the main body tapering near the tip to 0.500-inch. A hole with an inside diameter of 0.127-inch runs the full length of the probe's center line and serves to channel total pressure, subsequently converted into velocity pressure.

About four inches back from the hollow tip are fifteen tiny holes, spaced evenly around the probe's circumference. These bleed static pressure into a second channel leading to the base of the probe.

Machining of the hard molybdenum alloy—0.5 per cent titanium—was accomplished with an electric discharge unit, connected to a counterrotating feed developed by the arsenal's engineering staff. This technique was both accurate and relatively fast.

Trepanning the concentric groove that connects the base of the probe to the static-pressure inlet holes proved to be the biggest stumbling block. This annular groove, 9.8 inches deep and 0.100-inch wide, is separated from the outside wall of the probe by 0.150-inch of metal, and from the center hole by a 0.124-inch wall.

Because of its shape and tolerance, the groove was machined first by spinning both the discharge tool and the probe itself in opposite directions at a relative speed of about 440 r.p.m. Then the center hole was spark-machined, concentric with the trepanned hole within 0.001-inch.

BEFORE adopting the protective alloy for the molybdenum missile probe, arsenal researchers tried a number of other combinations. They quickly determined that an ablative coating—one which slowly transforms from a solid to a gas as heat is absorbed—would alter the probe's shape and, therefore, the air flow past it. Ablative coatings were abandoned because any change in the probe's external configuration resulted in erroneous readings.

Molybdenum offers high strength at elevated temperatures, but a means had to be found to protect the metal against oxidizing. Among the oxidation bar-

riers tested were ceramic-coated molybdenum, a heat-resistant refractory alloy, molybdenum with aluminum-silicon oxide, ceramic-coated stainless steel, and molybdenum with W-2 chromallizing.

Ceramic coatings were completely unsuitable. They actually pulled away from the probe, having a thermal coefficient of expansion approximately three times that of molybdenum. Of the materials evaluated, chromallized specimens successfully met the stringent test and fabrication requirements.

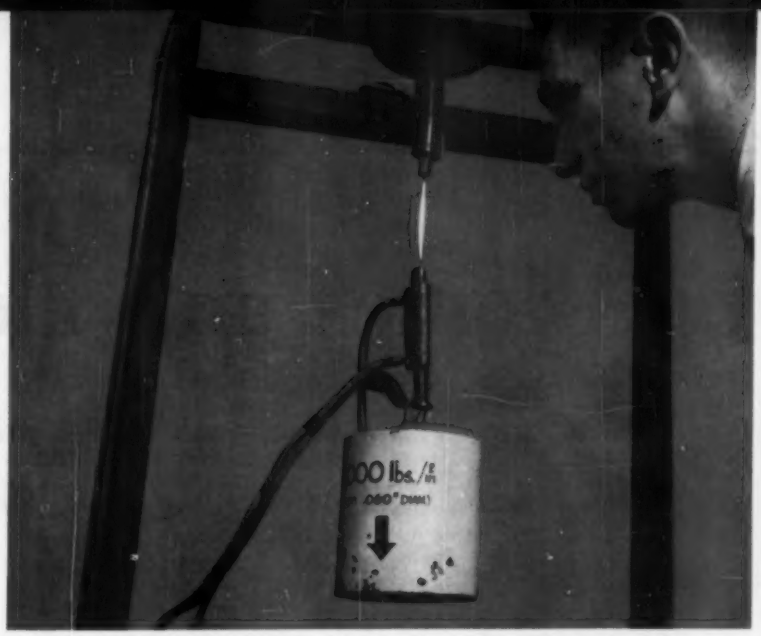
Unusually harsh test conditions were applied. The ceramic jet test facilities at Langley Air Force Base, Va., a National Aeronautics and Space Administration research center, provided airstream velocities above Mach 4 (four times the speed of sound at sea level), at temperatures of 3,850 degrees Fahrenheit for 45 seconds.

The diffusion alloy even withstood bombardment from ceramic fragments picked up from the heating bed in the test jet. Engineers felt that this factor, not normally encountered in flight, more than compensated for the fact that temperatures and air speeds of the test were somewhat lower than in actual missile operation.

Chromallizing substantially increases molybdenum's resistance to high-temperature oxidation. In fact, treated molybdenum samples have maintained their strength for extended periods at temperatures as high as 2,300 degrees Fahrenheit.

One company has heated a test-panel with a gas-air torch to 1,800 Fahrenheit in 30 seconds, held it at that temperature for 15 seconds, cooled it to room temperature in 45 seconds, and repeated this tortuous test 2,000 times without panel failure. A Government agency, interested in molybdenum piping, exposed tubing protected by the W-2 surface alloy to 2,500-degree steam for 6 hours without harm.

Picatinny Arsenal sends fabricated probes to the company's plant for treatment. There, probes are packed in a compound containing (1) proper proportions of chromium and other metal powders, (2) inert matter to keep the powders from sintering and to permit gas circulation, and (3) an energizer. Parts are arranged in a retort, then inserted in a furnace. Upon completion of the diffusion cycle, the retort is removed, allowed to cool, and the probes removed.



Chromallized molybdenum wire withstands temperature of 2,400° F. and load of 3,000 p.s.i. Untreated wire would distintegrate in seconds under same conditions.

The retort is sealed against air contamination. During diffusion, the active elements combine with the basis metal to form a range of new alloys. At the surface, the alloy is rich in the metals introduced, decreasing in alloy content until the original basis metal is finally reached.

Metallographic examination usually reveals two or three distinct layers, with boundaries at certain fixed percentages of alloying element. Depending on processing conditions, thickness of the surface alloy may be varied considerably. In the case of the missile probes, two mils was found to be enough.

With the advent of the diffusion alloy, molybdenum should become a more popular refractory material. Structurally, it retains a great deal of tensile strength at elevated temperatures; the 0.5 per cent titanium alloy has a strength of nearly 90,000 p.s.i. at 1,800 degrees Fahrenheit.

The chief drawback to using unprotected molybdenum has been its almost instantaneous oxidation; at about 1,400 degrees Fahrenheit, the metal changes directly to a volatile oxide, and literally goes up in smoke. Chromallized, however, molybdenum may soon see considerably broader use in jet-engine buckets, rocket motor components, nuclear reactor rods, and other applications where excessively high heat creates material selection difficulties.

Oxyacetylene torch consumes untreated molybdenum, right. Left, molybdenum treated with W-2 diffusion alloy glows hot but will not crack, flake, or oxidize.

Bionics and Defense

A new science solves the mysteries of biological cells and applies nature's secrets to the advancement of military electronic systems

Walter A. Murphy

BIONICS is an infant science. An offspring from the marriage of biology and electronics, it is destined to unlock the doors of biological cells, release more of nature's secrets, and apply the extracted knowledge to the advancement of military electronics systems. Both the exploration of outer space and the conquest of liquid space —the sea—could depend on the success of bold, imaginative progress in bionics.

Nature has a vast reservoir of living systems for our observation and analysis. Some of these systems employ extrasensitive, highly developed instruments and components organized into specific functions. Much knowledge of nature's techniques has already been extracted and applied toward modern technology.

A study of the beetle's eye, for instance, paid off in the design of instruments to measure the ground speed of airplanes, and the porpoise's wakeless maneuverings and its skin structure have told us how we might achieve low-drag for high-speed submarines.

MAN'S ingenuity for duplicating living things or using the principles thereof, has not always been applied to weapons systems or the advancement of medicine. Lifelike, spring-wound automatons were created and exhibited in the eighteenth century. French savant Jacques Voucanson's imitation duck, most famous of these synthetic creatures, could waddle and flap its wings; it could quack, eat, and drink. As if this weren't enough, Jacques' bird could peck up food and even "digest" it.

Mr. Murphy is with the industrial computer systems department, Radio Corporation of America, Natick, Mass.

Our aim is not to build automatons for the sake of imitation or duplication. We are trying to build solid defenses and eventually a free world. The careful, searching study of living systems might reveal mechanisms and techniques which will enable us to design simpler yet more effective components and systems—systems for peace and security through strength.

A brief look at nature's busy world of living things will serve to remind us that she has been using highly developed detection, acquisition, and attack mechanisms long before man invented the wheel.

The rattlesnake, for instance, has an organ that detects heat and can respond to a temperature change of one-thousandth of a degree. He seeks his prey at night while equipped with a sort of infrared detector unmatched by any man-made device.

The porpoise slips through the water quickly and quietly while detecting and then identifying other objects within a distance of two miles. Studies of the porpoise's skin and motion have led to antiturbulence devices which could, in turn, offer low-drag for high-speed submarines.

There is a fish that can detect a current of 200-billionths of an ampere per square centimeter of its body. With this electronic detection capability it can discriminate between glass rods differing in diameter by less than one-tenth of an inch.

The sonic detecting and ranging units of bats and owls is well known. Even more delicate and effective, however, is the microscopic ear of a moth that is often a prey of bats. The ear, tuned to the ultrasonic squeaks transmitted by the bat, enables this moth to take evasive action if a bat get too close. This natural instrument has already become one of man's laboratory devices—biologists have attached electrodes to its nerve and now have the best-known microphone for listening to bats.

LONG before man ventured beneath the sea in the submarine and the bathyscaph, the cranchid squid and the cuttlefish were using the principles of these inventions. The cuttlefish, actively controlling its buoyancy, employs its cuttlebone somewhat like a submarine commander uses the buoyancy tanks of his vessel. When the submarine is to dive, its buoyancy tanks are filled with water; when the vessel is to surface, the water is blown out of tanks by compressed air.

Instead of a compressed-air pump, the cuttlefish operates a sort of salt-balance pump for a buoyancy-regulating action. An osmotic force is set up by a difference of salt concentration between the fish's cuttlebone fluid and its blood. With any change in sea pressure, the osmotic pressure changes to balance the sea pressure.

The squid resembles the bathyscaph, designed by Jacques Piccard. The squid achieves buoyancy by trapping am-

monia in its coelomic cavity to reduce the density of the cavity fluid and this makes the creature buoyant. The bathyscaph has a chamber filled with gasoline, and this fluid-mechanical arrangement is equivalent to the squid's coelomic cavity and fluid. Both the squid and Mr. Piccard are contributing fuel to the advancement of bionics—the squid passively and Mr. Piccard actively.

More than serving as an example for the study of buoyancy and propulsion, this appalling creature, the squid, has recently become the subject of nerve study. Biologists have discovered a giant nerve in several squid species which is forty times thicker than the largest nerve previously analyzed. This means the scientist, instead of working with fibers thinner than a human hair, can study one almost as thick as a wooden match.

MAN sometimes thinks he's getting too complex in his design of weapon systems. He's right in his thinking if he finds, in any instance, that his design could have been simpler, less expensive to maintain, and still just as effective. Nature's attack systems are sometimes complex, sometimes relatively simple, usually effective.

The assassin bug is a living example of one of the most lethal, complex weapons ever seen. The struggles and strains of other powerful, fast-moving insects are futile against its tactics and equipment. The assassin bug (or *Platymeris*) has remarkable adhesive pads on its four legs which enable it to resist a steady pull of 65 to 70 grams while it clings to the glasslike surface of its prey, the rhinoceros beetle.

These pads are very small flexible structures, each composed of 80,000 minute hairs. Each hair is a hollow tube about 0.05-mm. long with a flattened, fanned end. This adhesive, multitubed mechanism allows this marvelous attacker to stand firm on its prey while injecting powerful venom through a pump syringe of the most elaborate design. Its prey is dead within a few seconds after the assassin leaps and pounces.

Man's accomplishments in miniaturization are nothing compared to nature's living units of complexity-in-miniature. The aphid, for instance, is an insect barely larger than the head of a pin, and with a leg smaller than the human hair. This leg, visible only under magnification, is a working complex of nerves, tubes, and millions of cells. Each cell contains some "genetic" knowledge that controls its future development.

WHEN we compare these cells to the miniaturized electronics parts of a modern component in a system, we find that the aphid, a whole living system with billions of component parts, is about the same size as the smallest modern diode. The modern diode is to the computer system what the cell is to the aphid; yet the diode is about the same size as the aphid.

What are the trends and goals relative to bionics? Regarding trends and break-throughs in what has been called "bioelectronics," Herman P. Schwan, professor of electrical engineering at the University of Pennsylvania, cited a need for more effort in two activities that stand out in importance: training bioengineers and applying electronics principles to the biological sciences.

No one suggests that we try to imitate nature's creatures in every detail but that we study certain aspects such as their behavior patterns. The United States Navy is continuing its studies on the behavior of porpoises at Marineland near Los Angeles. Using highly sophisticated electronic instrumentation, the Navy is trying to determine how smart these mammals are and where they get their sensing ability.

The Office of Naval Research has sponsored many studies in self-organizing systems (equivalent to the "bionics" term used by the Air Force). Research is continuing. Closer studies are being made of biological organisms such as the eye, ear, and brain. Out of studies like this have come reports such as "What the Frog's Eye Tells the Frog's Brain" by a group of M.I.T. researchers.

ONR researchers hope to someday develop components which will perform the same functions as biological organisms. The attempt to duplicate the neuron, mysterious cell of the nervous system, could lead to mathematical forms and finally biological machines.

Certain functions of the neuron already have been duplicated in an electronic circuit built by Von Fourster at the University of Illinois, and General Electric's research laboratory is building a piece of equipment to duplicate some functions of the neuron. G.E.'s unit will be a practical information system about the size of a transistorized portable tape recorder.

Scientists have known for years that brains, human and animal, are highly efficient and complex computers. Data from the senses are turned into digital (numerical) code and transmitted along the nerves to the brain. The brain converts to analog (quantitative) code and uses the data for the thinking process.

While we are studying the fundamental workings of general life processes, engineering applications and techniques are producing newer, humanlike brain machines. Recent experiments by the Air Force Cambridge Research Laboratories indicate that it will soon be possible for operators to communicate with digital computers by voice for the insertion of real-time data. Tests have shown that a small digital computer, with a relatively simple speech-analysis accessory, has been able to recognize different spoken words.

A NEW electronic brain is being built by Dr. W. K. Taylor of the University of London. It will be able to read, write, and even talk. The talking will be heard as squeaks of varying pitch. The brain, using 4,000 cells and an eye of 100 photoelectric cells, will have a built-in selector which can decide which problems are more important. As a research tool, it will help researchers learn more about the workings of the human brain. It might even provide ways of detecting the onset of a mental breakdown.

Electron "neurons" have been developed by the Ford Motor Company's Aeronutronic Division with a little device, smaller than a penny, called MIND (Magnetic Integrator Neuron Duplicator). The MIND is modeled after the synaptic junction of man's and animal's nervous tissue. The junction

"The careful, searching study of living systems might reveal mechanisms and techniques which will enable us to design simpler yet more effective components and systems for peace and security through strength."

serves as a relay point for passing signals from one nerve cell to another. It acts as a door that allows something specific to pass from one room to another and then closes to everything else. It corresponds, in a small way, to property filters.

The study of property filters looks like a pay-off activity. These filters of living organisms screen out certain types of information and allow other types to pass. The frog has strong property filters. Its eye can focus sharply on a fly and its trajectory while seeing other things as a blur.

Another property filter permits one frog to hear another accurately while missing other sounds at the same time. The data-processing job of a learning machine would be simplified by filters like these.

THE frog, a popular specimen, has told us other things. It was so-called "animal electricity" first discovered in the frog that led to the measure of electromotive force. When Professor Luigi Galvani's assistant accidentally touched the crural nerves of the frog with his scalpel, the limb muscles of the creature seemed to contract and go into tonic convulsions.

This discovery, one of the most important in anatomy and electricity, prompted Alexander Volta to further experiment with the frog. Volta found he could cause the frog's muscles to twitch by touching them with two dissimilar metals. He reasoned from this that the metals generated a current, the nerve conducted this current, and the muscles responded to close the loop.

Computer development recently was nursed along a little more by a design technique called self-adaptation. Now the computer adapts itself to meet each situation as it arises. Like the human mind, it can handle one situation at a time and, when the occasion calls for it, move on to the next. The self-adapting computer "thinks" more effectively and perhaps will function to help us in our own studies of the human brain.

Using the computer as a research and investigating machine to learn how we humans go about solving problems can lead to firm conclusions such as: use of better problem-solving techniques and the development of combinations of machine and human intelligence.

The Research and Development Command at Wright-Patterson Air Force Base, Dayton, Ohio, is inviting informal proposals outlining ideas for bionics research projects. Almost $1,000,000 will be spent this year for bionics research work. Of particular interest are the reactions of mathematical models of living functions and the development of components, networks, and systems capable of performing these functions.

The mission of the Air Research and Development Command (to help create new scientific technology and accelerate timely translation into military systems) depends upon strenuous programmed effort in the ever-widening spectrum of research and development. The Command's success in designing superior future weapons hinges on advances in applied research objectives, and some of these objectives lie in bionics.

One of these ambitions is a capability desired by the end of 1967: to find out whether machines can be made to recognize automatically and classify complex patterns. Through the study and simulation of biological pattern-recognizing systems it is hoped that patterns (such as those features, for instance, that appear on radarscope displays) could be recognized by man-made devices and used for the control of advanced data processing and other functions. Though some pattern-recognition devices have been made, there is still far more knowledge of the subject than engineering application of it.

The Air Research and Development Command is conducting studies of nervous systems to design more reliable subsystems from unreliable components. Though the nervous system is much more complex and contains many more components than a weapons guidance system, it operates successfully for many years because of circuitry principles involved. The neural network could provide important clues for the design of reliable systems with relatively unreliable components.

AN objective which supports and supplements these studies by ARDC is the plan to develop mathematical and logical modules and methods for describing and understanding complex biological systems. If the superior biological mechanisms of living things can be fully understood, an automatic, error-free, real-time, intelligent data-processing system might become a reality instead of being an objective.

Creatures of the deep are showing us techniques and self-organizing functions that will lead to developments in greater diving, propulsion, detection, navigation, and ranging capability. A natural extension of this would be safer deployment of major weapons systems, faster, quieter, wakeless submarines and torpedoes, more effective early-warning devices, more accurate navigation and ranging, and longer range communications. In general, weapons systems could be far more effective through a magnitude of undersea mobility which is now impossible.

And then there could be dividends —those unexpected but possible extras that sometimes ride in on the wake of a development. Studies of living things will, at least, boost the power of modern man to build the world anew.

BIONICS will not only provide the feelers and thinkers for exploring and using the sea, the stethoscope for listening to the rhythmic pulse and heartbeat of nature, but perhaps the answer to these questions: What will man eat in space? How can we outlaw biological warfare forever? Is it a submarine? . . . If so, is it ours?

To be successful and fruitful, bionics needs recognition and support. A vigorous program to advance this new science might include: the promotion and recognition of bionics as a potential vehicle helping to carry our multiplexed technology beyond the fringes of space and the mysterious depths of the sea; the early training of engineers and biologists to use this vehicle.

The vast, heaving arena between our continents is virtually untouched and as yet uncontrolled by any one nation. Its domination by any nation means a firm restricting grip on the arms of the free world. One nation is striving already to make it a liquid satellite of submarine units. Not until we realize that we are now in a world struggle will we act accordingly, with the quiet aggressiveness and skill found in some of nature's living systems.

Together with working the organizational "bugs" out of our defense setup, we should somehow get the bionics bug into the research effort.

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MAY-JUNE 1961

The following companies have shown by their interests in the design and production of ordnance that they are ready to serve the United States through industrial preparedness for national security and peace. Such companies as these are indicative of the industrial strength of the Nation upon which the military might of the armed forces depends.

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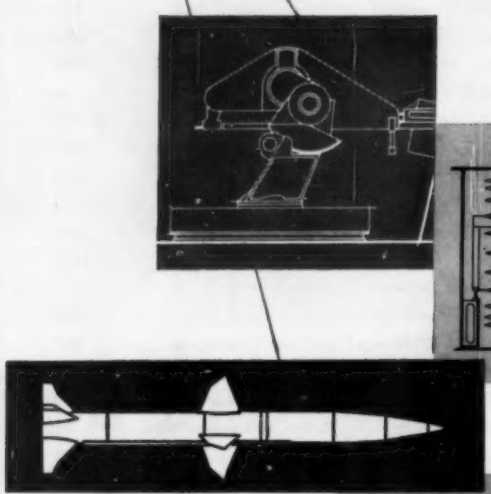
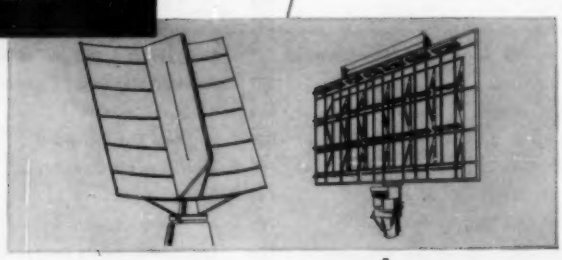
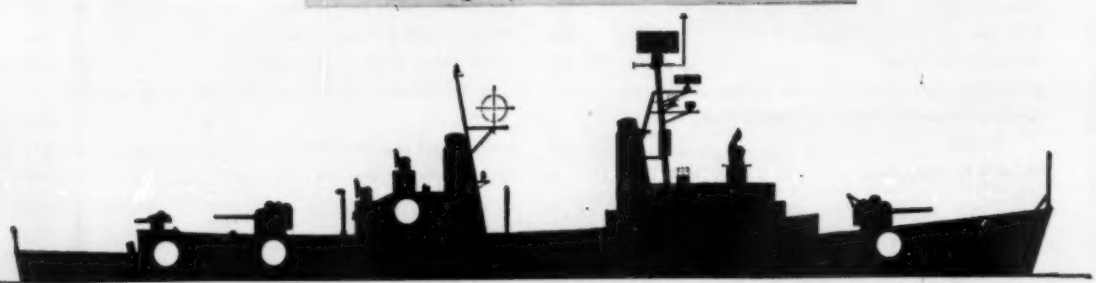
IT'S THE MAN BEHIND THE SCENE WHO COUNTS

Vitro has performed the little-known but important role of systems engineering coordinator on more than 60 military systems. Take a careful look at this function – integrating components of complex range instrumentation and shipboard weapon systems. This backstage assignment has resulted in "on-time" performance to the military services.

Vitro







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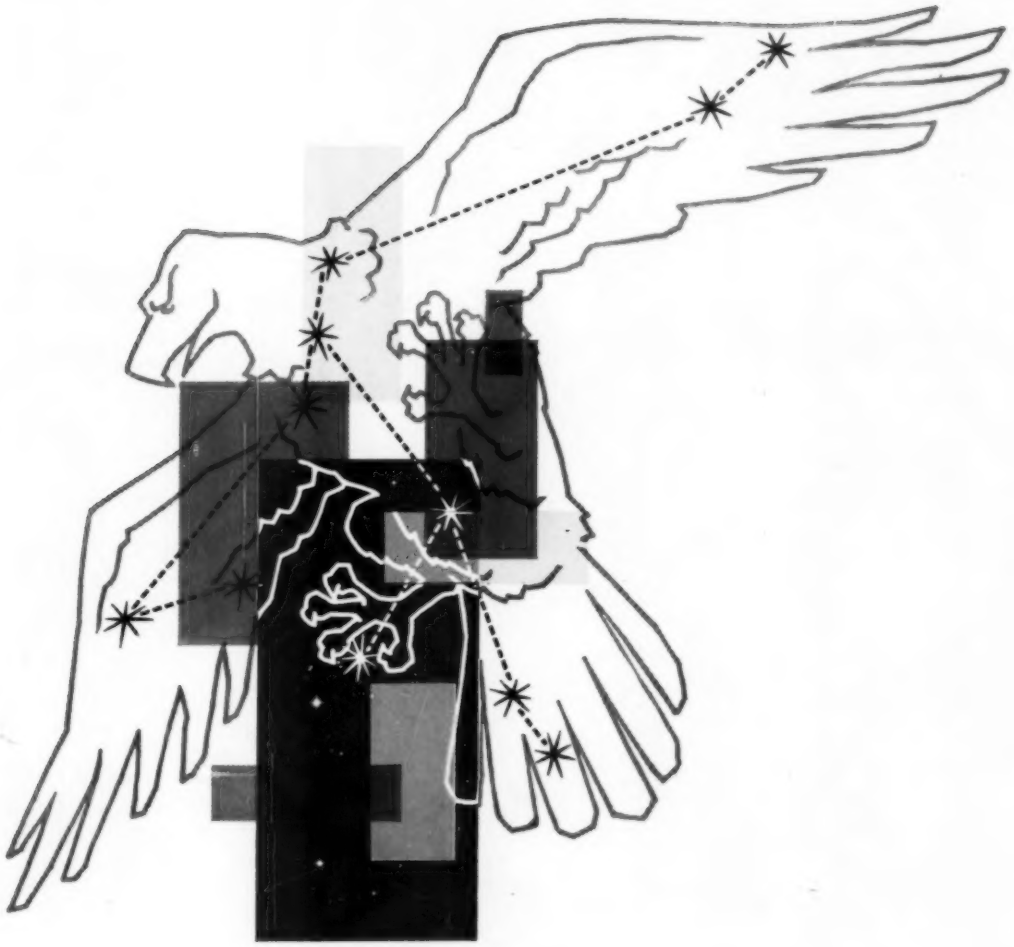

Look to Parsons for PERFORMANCE

AEROSPACE ENGINEERING—*Second to None*

Unlike legendary Aquila, the Eagle, whose powerful wings carried him into the heavens, man, in his conquest of space, must depend upon Imaginative Engineering. Parsons' resourcefulness in Imaginative Engineering has been demonstrated on a wide variety of Aerospace projects for industry and government. Close liaison between all operating and service groups permits efficient and economical handling of projects of any size.

The Ralph M. Parsons Company, Los Angeles, United States Offices: Pasadena, Houston, Huntsville, New York, Washington. International Offices: Asmara, Baghdad, Bangkok, Beirut, Cairo, Calgary, Dacca, Djakarta, Jeddah, Karachi, London, New Delhi, Paris, Teheran, Tokyo, Toronto.

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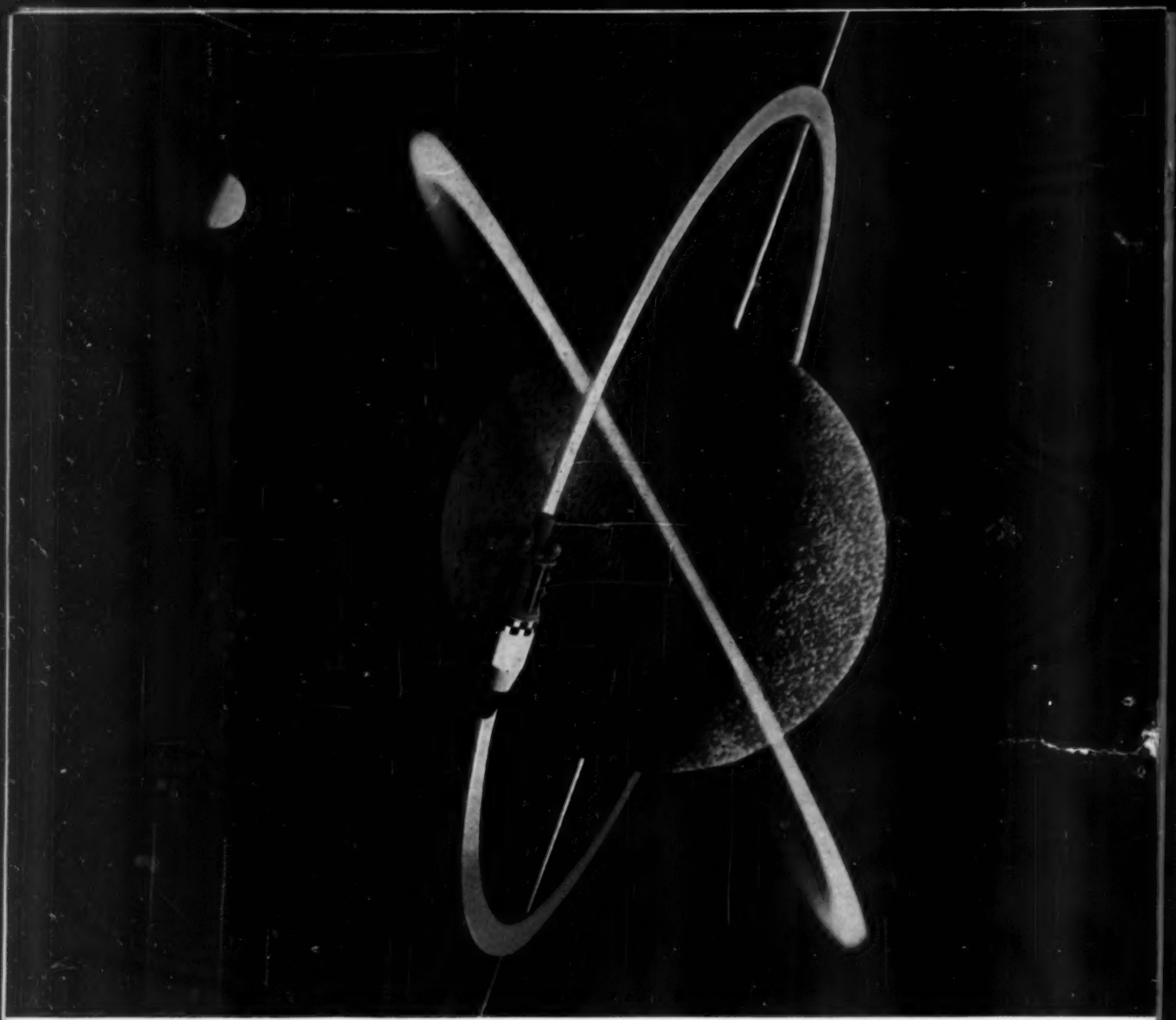

Bell-powered Agena satellites in orbit — symbolized.

THE ENGINE WITH THE FUTURE

Reliability . . . Efficiency . . . Flexibility.
In space, these words have a million-dollar meaning.

Vast sums of money and vital scientific data ride on these built-in attributes of Bell Aerosystem's rocket engine for Lockheed's Agena satellite, second stage of the Air Force Discoverer series.

The Agena engine, designed with space in mind long before space became a household word, has fulfilled its every mission and has placed more tons of useful payload into orbit than any other power plant. Its operational reliability is backed by six years of development and 5,000 test firings.

This Bell engine now has re-start capability — the first in the nation. This means that its satellite can change orbit **in space** without the penalty of extra engines. Presently in production, this engine also is adaptable to new fuels and new assignments and, consequently, is programmed for important military and peaceful space ventures of the future.

Agena's engine is typical of the exciting projects in Bell's rocket propulsion center. It is part of the dynamic new approach of a company that's forging ahead in rocketry, avionics and space techniques. These skills serve all government agencies. Engineers and scientists anxious for a new kind of personal challenge can find it at Bell.

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